Compressed Air Magazine

JANUARY 1947

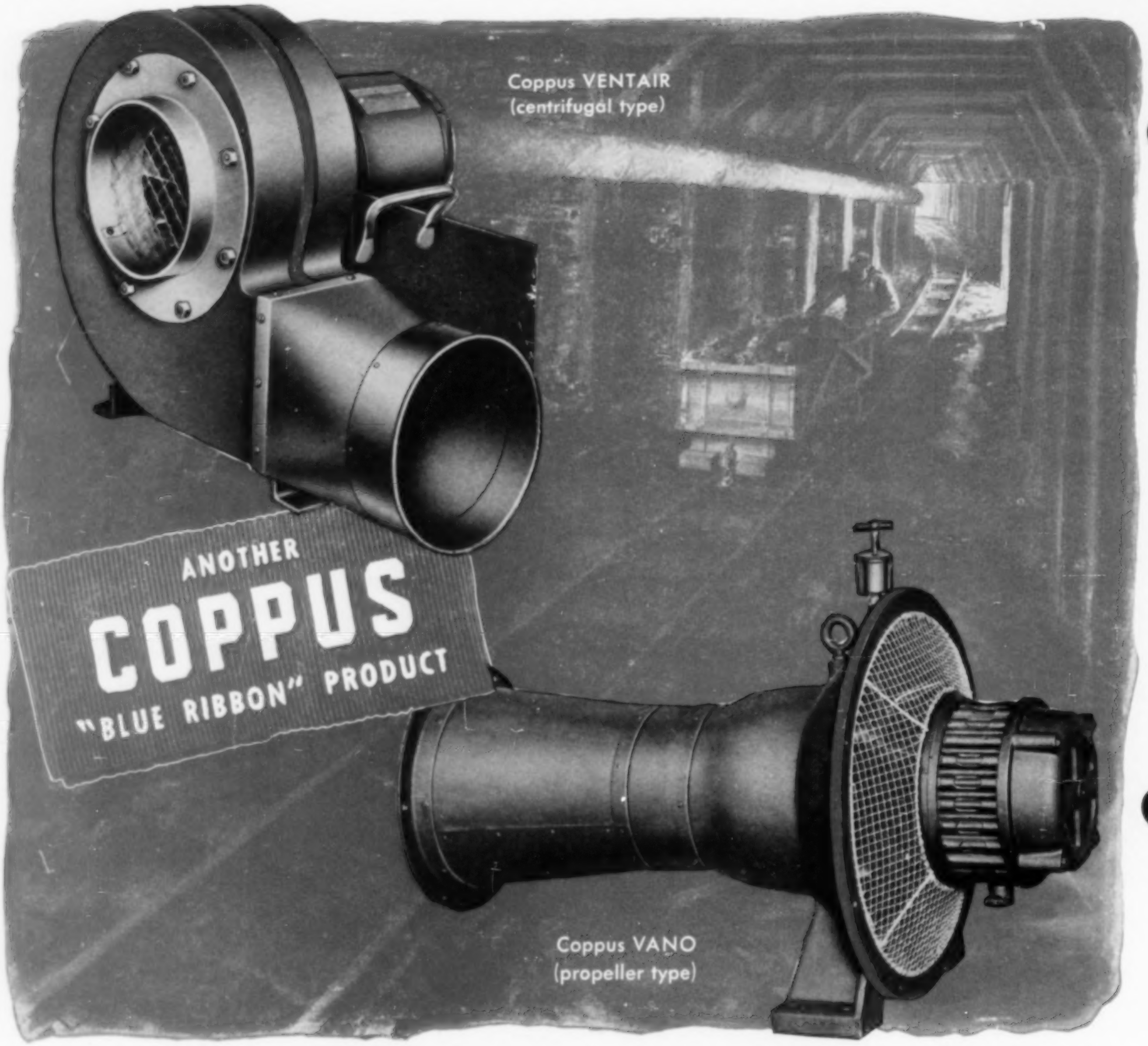
DRILL RUNNER IN JANUARY ATTIRE

Hard-rock men defied the elements to finish great Shipshaw project on time.

(See page 2)

VOLUME 52 · NUMBER 1

NEW YORK · LONDON



Two Blowers . . . One Purpose: 30 to 100% More Air

Why two totally different blower types? Because the requirements of mine ventilation fall into two entirely different categories.

For high pressures, long pipe lines, use the Coppus VENTAIR (centrifugal type). For medium pressures, shorter pipe lines, the Coppus VANO (propeller type) is best. One or the other will give you more air per given power consumption than other blowers — from 30% to 100% more. Can be used as blowers or exhausters, capacities up to 90,000 CFM, with compressed air or electric motor drive.

Only Coppus makes both types. And, for quick recognition, each wears the famous "Blue Ribbon," distinguishing mark of top-quality engineering, materials and performance. This blue band is your guarantee of better mine ventilation . . . Look for it.

Representatives listed in METAL & Non-METALLIC MINING CATALOGS. Other Coppus "Blue Ribbon" products: steam turbines, gas burners, heat killers, air filters, blowers and exhausters for special purposes. See also THOMAS' REGISTER . . . Coppus Engineering Corporation, 541 Park Ave., Worcester 2, Mass.

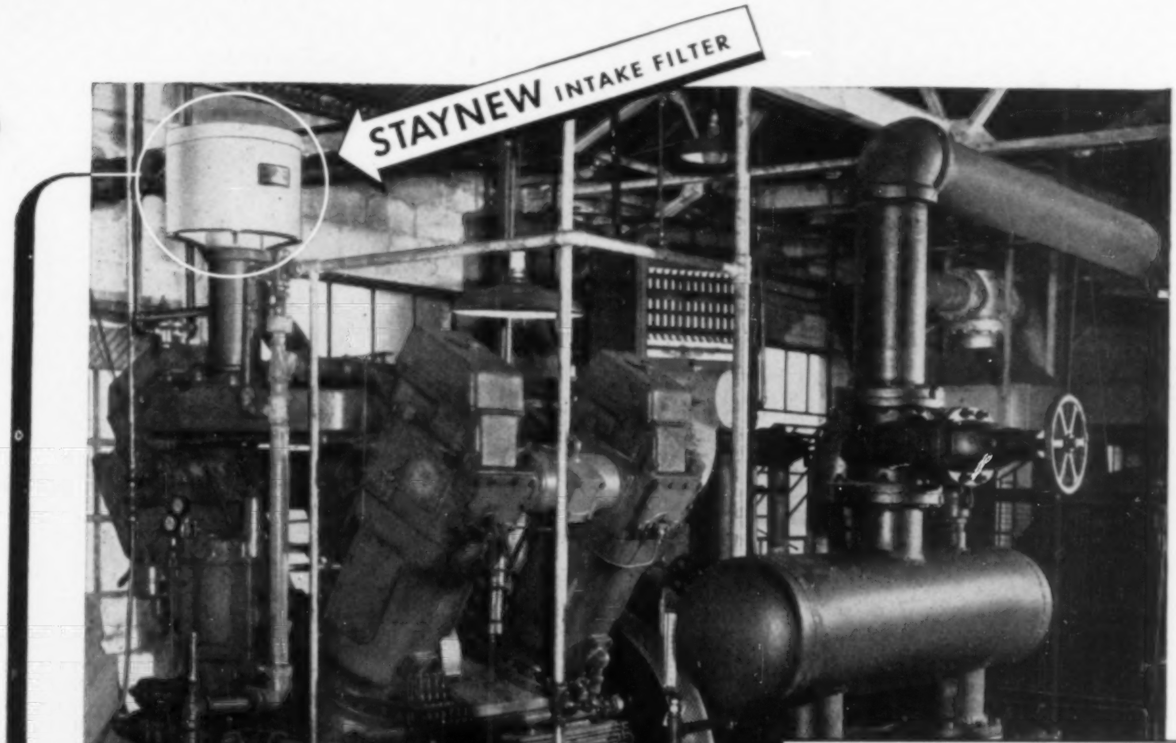
COPPUS ENGINEERING CORPORATION
201 Park Avenue, Worcester 2, Mass.

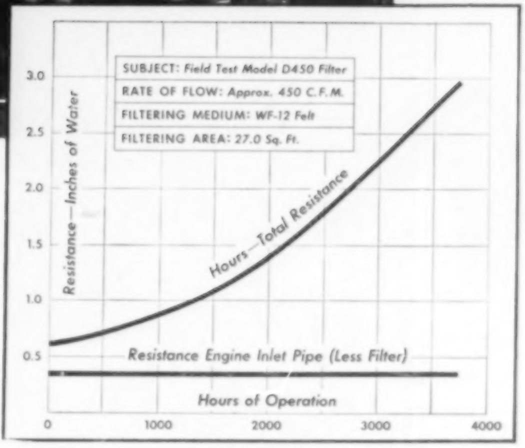
Please send: Bulletin 130........

Name..

Company ....

Address.......................................





3761 HOURS CONTINUOUS OPERATION WITHOUT ATTENTION

Yet Filter Resistance Is Only 2.73 Inches of Water

This filter, installed on a Diesel-powered compressor, operates under unusually severe conditions. Intake air is heavily loaded with dust and oil; the dust due to the close proximity of a railroad siding where bulk lime, sand, and coal are handled—the oil to two additional Diesel-powered compressors operating in the same room.

Such a case history is not unusual. Reports are frequently received of Staynew Filters operating under less severe conditions for two or more years without attention—with the initially high efficiency rising as dust load increases.

Ease of cleaning as well as infrequency of cleaning is also an important feature, requiring only a few minutes with the specially designed Staynew Cleaning Nozzle.

More and more experienced operators of compressor and engine equipment specify Staynew Intake Filters—not only because of the minimum attention required, but also because these filters:

- ★ **Provide positive protection**
- ★ **Require no pre-coat or filter aid**
- ★ **Are unaffected by extremes of temperature**
- ★ **Permit use of oversize filters (air velocity not critical)**
- ★ **Are ideal for use with carbon ring compressors**

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

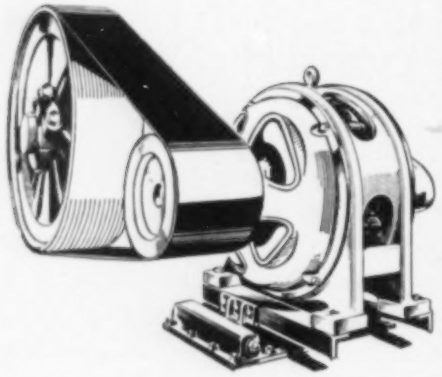
DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

Representatives in Principal Cities

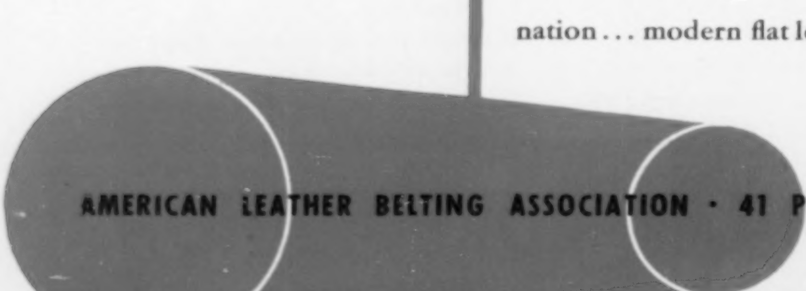
A PERFECT PAIR

for longer wear

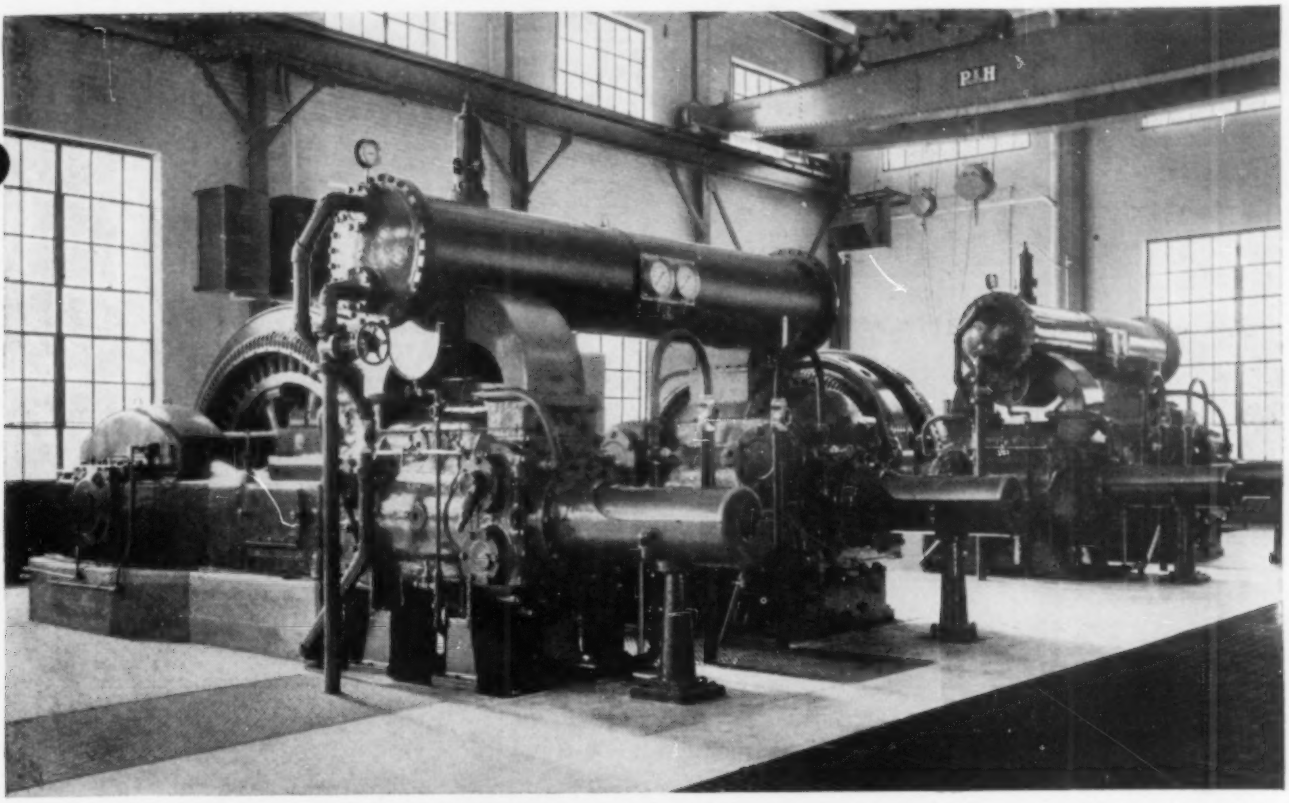


IN MODERN POWER TRANSMISSION
IT'S FLAT LEATHER BELTING
AND A PIVOTED MOTOR BASE

No other type of mechanical power transmission gives the operator so much assurance of smooth, uninterrupted trouble-free production as this modern drive. It's easy to install, easy to maintain, always reliable. Specify this winning combination . . . modern flat leather belting . . . a pivoted motor base.



AMERICAN LEATHER BELTING ASSOCIATION · 41 PARK ROW · NEW YORK 7, N. Y.



Keep Compressor Operating Costs LOW!

GIVE your compressors really *Effective Lubrication*—with the *Texaco Alcaid, Algol or Ursa Oil* recommended for your particular requirements—and you'll find that their efficiency stays high—operating costs low.

Texaco Alcaid, Algol or Ursa Oils meet the requirements of every type and size of compressor. They prevent formation of hard carbon deposits—keep rings free, valve action lively, ports open, air lines clear. Use them in your compressors to assure fewer repairs and replacements—fewer overhauls.

For Texaco Products and Lubrication Engineering Service, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

PROLONG DRILL LIFE

Texaco Rock Drill Lubricants (E.P.) will make your drills last longer, operate more dependably and economically. They are "extreme pressure" lubricants—stand up in the heaviest service, resist wash-out, prevent rust, greatly reduce wear and repairs. They meet the lubrication requirements of every type of drill design and operating condition.

TEXACO REG. T.M.

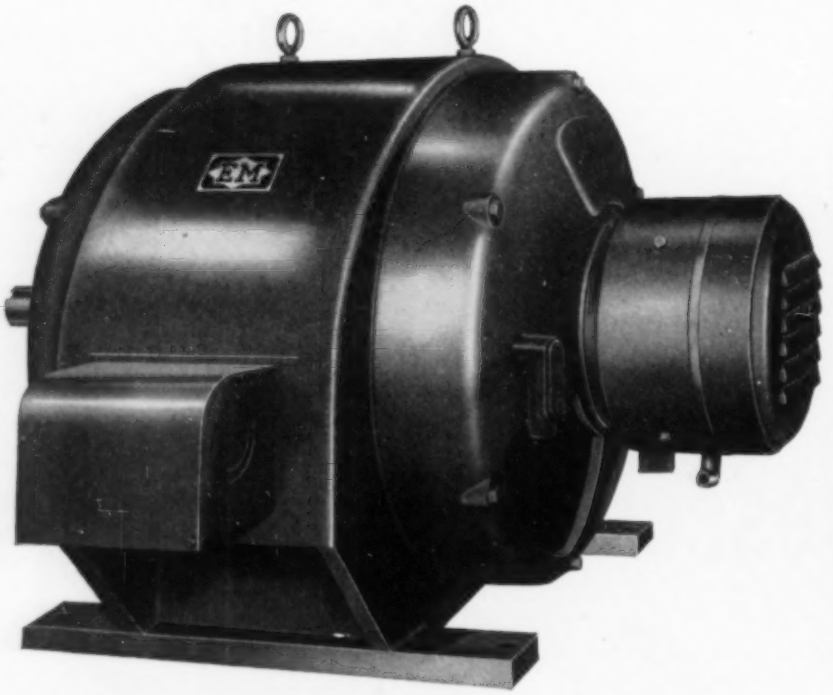
TEXACO Lubricants

FOR ALL AIR COMPRESSORS AND TOOLS

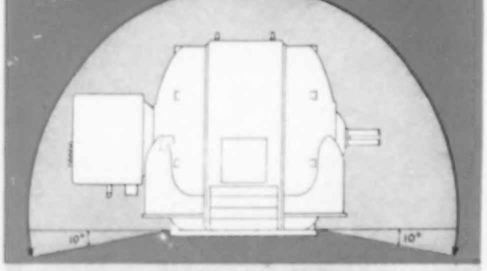
Tune in... TEXACO STAR THEATRE presents the NEW EDDIE BRACKEN SHOW every Sunday night. Metropolitan Opera broadcasts every Saturday afternoon.

New Heavy-Duty
Synchronous Motors

Advanced Design . . . Extra Protection

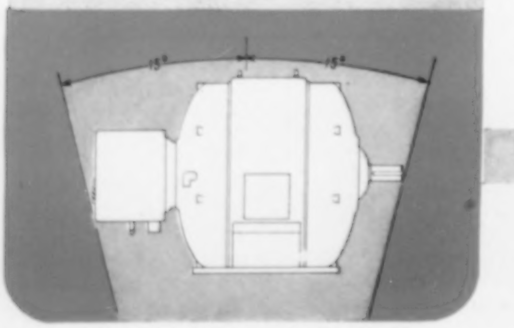


- PROTECTION from external damage . . . Drip-proof and splash-proof construction
- SAFETY against electrical breakdown . . . Solidly braced coils, extra tough insulation
- STRENGTH without excessive weight . . . Continuous welded steel plate frame
- CONVENIENCE of inspection and cleaning . . . Streamlined housing, ready accessibility



200 degree arc of protection provides defense against splashing or flying particles in the splash-proof design.

30 degree arc of protection safeguards the drip-proof type from falling liquids or particles.



More jobs can now have the advantages that make E-M Synchronous Motors "the most efficient drive in industry". . . for the new Heavy-Duty line provides extra protection, assures most reliable operation in adverse locations.

Frame construction shuts out falling dirt and liquids, makes operation quieter. Smooth, rounded exterior invites easy cleaning. Brush inspection and blowing out is simplified with access plates designed for speedy removal.

Dependability increases with anti-friction or modern one-to-one ratio sleeve bearings in larger sizes and with anti-friction bearings in small sizes. All bearings can be cleaned and refilled without motor disassembly.

Add the new E-M protective features to the already recognized advantages of the synchronous motor—direct coupling, torque and kva requirements to fit the job, power factor correction and high efficiency—and you have the latest example of the specialized E-M engineering that provides the best in synchronous motors.

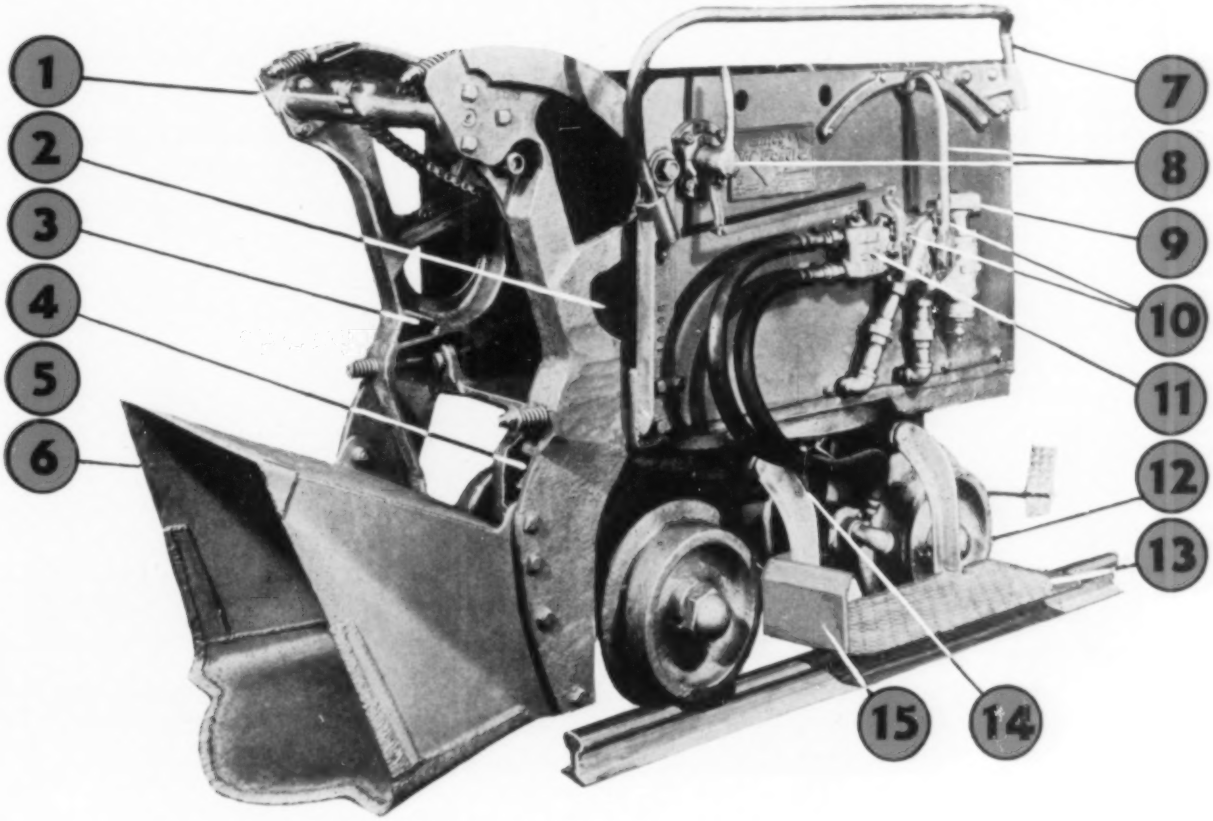
Your nearby E-M field engineer is the man to see for the best in synchronous motors.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

Leaders in Synchronous Motor Development
The Most Efficient Drive in Industry

Load in Safety with RockerShovels



The RockerShovel is the choice of the men working underground for its speed, efficiency and ease of operation and also for its many safety features, such as:

1—Strong single chain pull from center point prevents binding.
2—Positive completely enclosed automatic centering. Does not transmit shock to operators hands.
3—Heavy-duty rocker-arms provide trouble-free loading.
4—Multi-step digging width controls prevents upsetting timbers and digging into ribs.
5—Simple strong design and construction—free from trouble making gadgets and make-shift devices.
6—Carefully designed bucket tailored for job — prevents spilling over side of car.
7—Rigid tubular guard bar protects both hands of operator.
8—Convenient location of controls does not tire operator.
9—Safety air inlet swivel will not permit hose to swing on operator.
10—Safety balance springs on controls returns handles to neutral position when released.
11—Convenient arrangement of control parts eliminates service hazard.
12—Wide tread cast steel wheels with deep flanges provide extra stability.
13—Heavy-duty rigid step plate and support construction will not fold up on operators feet or tip when going into muck.
14—Lowest center of gravity of any commercial loader.
15—Safety toe guard on platform protects operators feet from rolling muck.

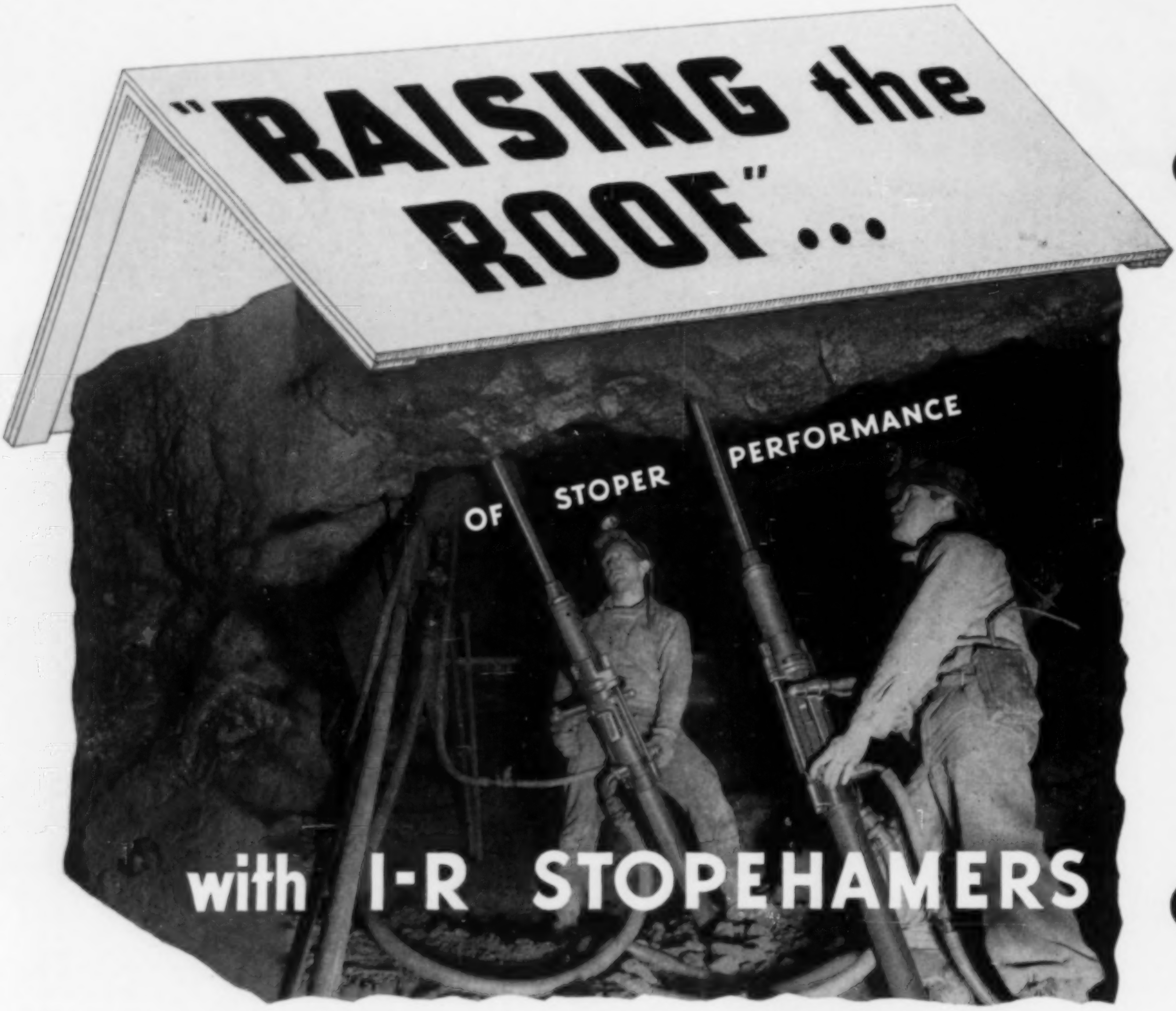
Protect your men and increase their production by using RockerShovels. Write for more information:

EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturer of Underground Rock Loading Machines

Executive Offices and Factories — Salt Lake City 8, Utah:
Branches — 67 Wall St., New York 5 — 111 W. Washington St., Chicago 2 — Mills Bldg., El Paso — 1217 - 7th St., Sacramento 14



The *ease of handling* and *durability* of the Ingersoll-Rand R-48 and R-58 automatically-rotated Stoper drills have set a new standard in up-hole drilling performance.

Drilling records from mines in many parts of the country show these drills to be far ahead in footage drilled per shift, in ability to stay on the job, and better satisfied miners.

Here are a few of the reasons for the outstanding popularity of these drills:

1. They are the fastest drilling Stopehamers we have ever built.
2. Positive, powerful rotation—assured by air-thrown block pawls.
3. Extra power and longer life—due to new piston design with heavier sections.
4. Dirt-free interior—cuttings and water kept from entering drill by an automatic chuck-cleaning system.
5. Easy collaring and avoidance of stuck steels made possible by a flexible and sensitive feed control.
6. Ease of handling and PERFECT balance provided by proper location of operating handle, throttle, and feed control.

SPECIFICATIONS

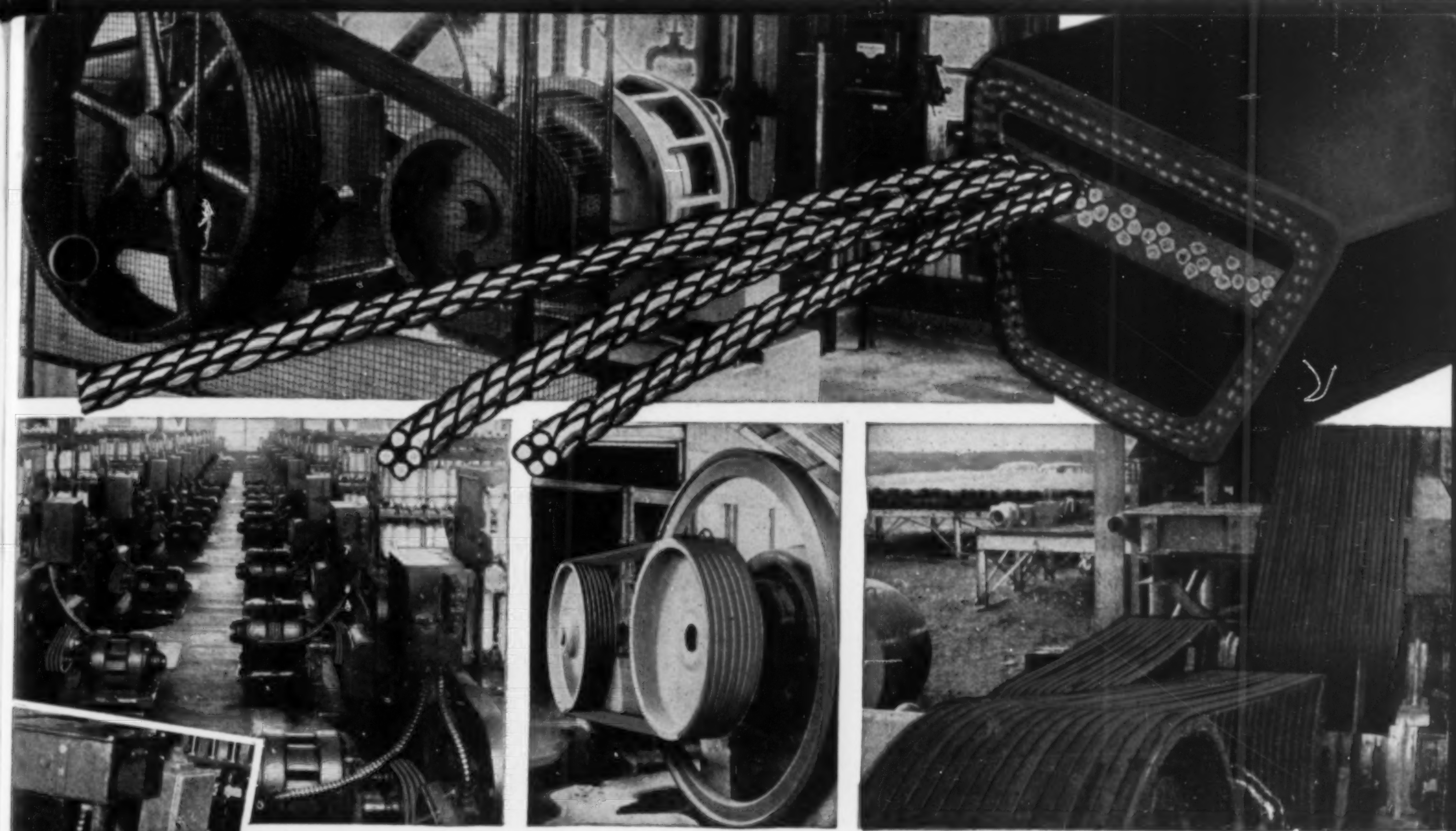
	R-48	R-58
WEIGHT, LB.	98	116
OVERALL LENGTH, IN.	58	59
BORE, IN.	2¾	3⅛
FEED TRAVEL, IN.	24¹⁵⁄₁₆	25
STEEL CHANGE, IN.	18	18

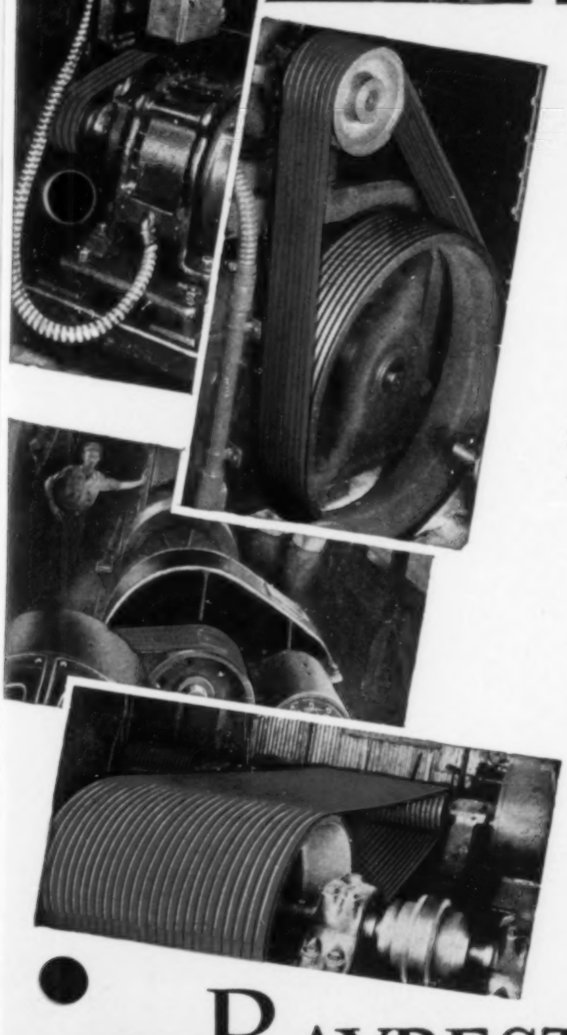
COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO BLOWERS • CONDENSERS
CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

These and many other features built into these drills are "Raising the Roof" of stoper performance.

Ingersoll-Rand

11 Broadway, New York 4, N. Y.   5-901





8 DISTINCT ADVANTAGES in

Condor Whipcord V-BELTS

1. Wide margin of strength
2. Minimum inelastic stretch
3. Uniform flexibility
4. Maximum resistance to structural breakdown
5. Smooth running
6. Maximum traction
7. High resistance to side wear
8. Correct lateral reinforcement

The outstanding difference in Condor V-Belt construction is the Whipcord *Strength Member* illustrated in the above cross section. This backbone of draw-power is composed of strong strands of cotton cord made to Manhattan's own specifications, impregnated and encased in strong, tenacious, slow-aging *Flexlastics* . . . Other factors being equal, the useful life of a V-Belt is limited by excessive stretch. The function of the Condor Whipcord *Strength Member* section is to take the load and prevent undue stretch.

V-Belt Bulletin No. 6868B (mailed on request) gives more details of the long-wearing construction and includes helpful tables.

Available also in Paranite G.O.P. (Gas-, Oil-Proof) and Non-Spark compounds of Flexlastics.

The term FLEXLASTICS is an exclusive MANHATTAN trade mark. Only MANHATTAN can make FLEXLASTICS.

RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION

EXECUTIVE OFFICES AND FACTORIES PASSAIC, NEW JERSEY

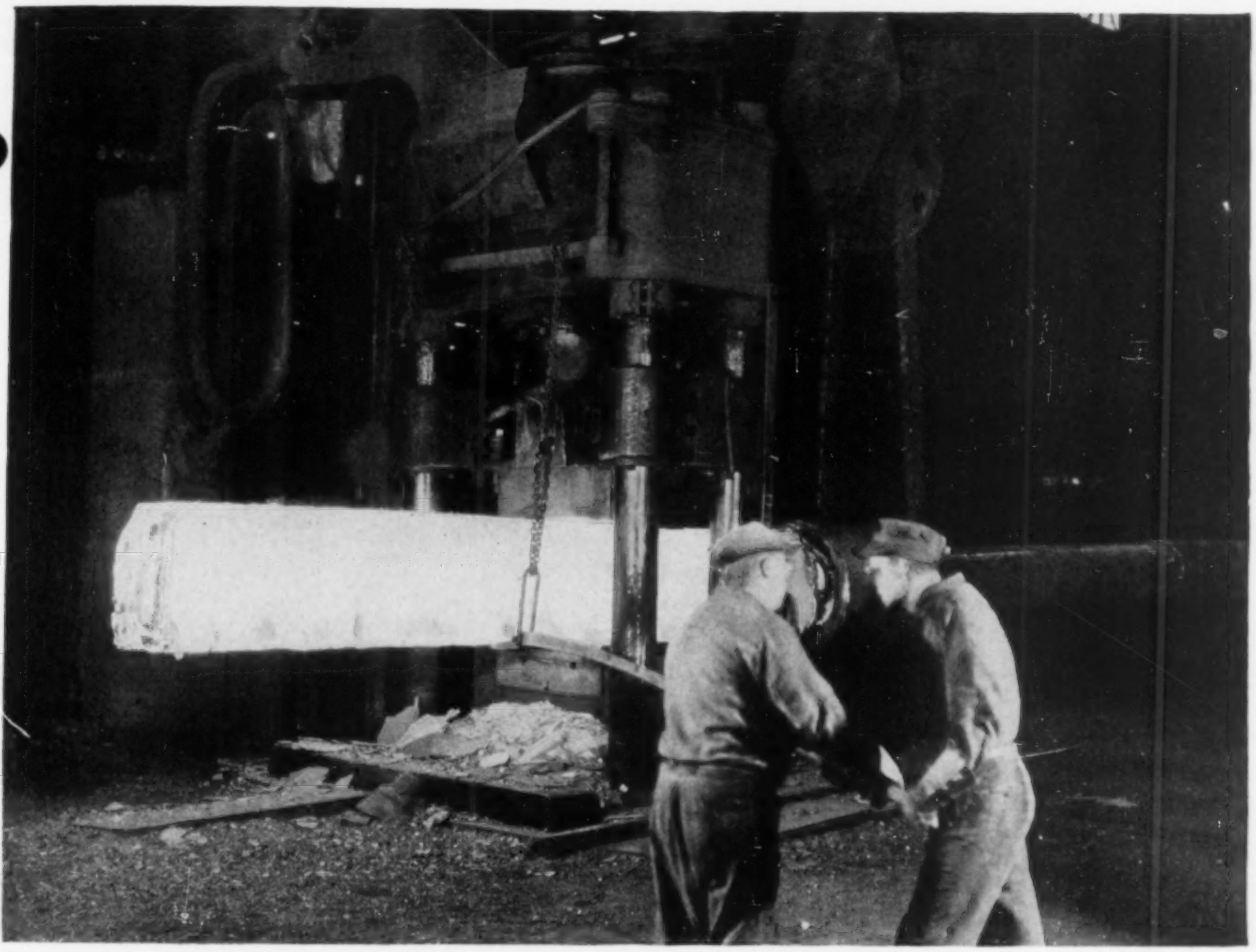
CUSTOM-MADE CLUTCHES EXCLUSIVELY

Do you require a few or a few hundred clutches to meet special operating conditions? Our new plant, completed last spring, has been equipped with the most up-to-date precision machines for producing custom-made clutches.

The *Flex-Disc* Clutches were tailor-made for *I-R Mobil-Air* Compressors, giving them easy, trouble-free starting under all temperature conditions. Also designed and built here are clutches for punch presses and power shovels, special motor starting types of clutches, automatic clutches for railroad generators, etc., etc.

All clutches produced here are designed to solve specific problems of our customers. We invite inquiries concerning requirements that cannot be met satisfactorily by commercially available types of clutches.

INDUSTRIAL CLUTCH CORPORATION
515 FREDERICK STREET WAUKESHA, WISCONSIN



the Forgesmithing factor in "OK" steel forgings

STEEL MAKERS
FORGESMITHS
HEAT TREATERS
MACHINISTS

● Mighty as is the power of the forging press, the long acquired skill of the forgesmith is a most vital factor. To produce correct grain flow without impact damage to the structure of the steel is a matter of personal skill. The metal is formed by a powerful squeeze which penetrates throughout the ingot. The proper application of this squeeze to produce a forging of uniform structure is skill from experience.

National Forge standards call for careful pre-heating ("soaking") to the prescribed forging temperature, completion of the forgesmithing before the ingot cools below safe working heat and careful temperature control after forging to prevent cooling strains impairing the strength of the steel. As National Forge makes its own basic electric steel, it has the advantage of working with steel that is specifically made for each forging under strict metallurgical control.

Let us give you the latest facts and data applying to the type of steel forgings required in your plant or product.

National Forge
AND ORDNANCE COMPANY
Irvine, Warren County, Pennsylvania

The most important advance in motor design in 58 YEARS...

Features and improvements demanded most by users
ALL WRAPPED IN A SINGLE PACKAGE

When Westinghouse engineers began designing a postwar motor they abandoned the concept that all motors must be cousins. Instead, they asked electric motor users *what they wanted* in motors . . . features they couldn't buy in any one motor.

These features demanded most by motor users are *all* incorporated in the new Life-Line Motors:

ALL-STEEL PROTECTION. All frames, feet and brackets are HEAVY STEEL. Life-Line Motor stators are far stronger—a new core locking device eliminates rivets.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

the New WESTINGHOUSE Life-Line MOTOR

It's completely new . . . it's completely different . . . it wraps up the advances made in "custom-built" wartime motors in a single package!

For 58 years, induction motors have been built fundamentally alike. Differences have been minor . . . improvements gradual. Today, in the new Life-Line, Westinghouse presents a major departure from accepted ideas of standard-motor limitations.

Life-Line, today, offers industry a truly all-steel protected motor. All exposed surfaces are HEAVY STEEL—frames of even the smallest sizes are 3/8" thick.

More compact power is packed in Life-Line. For example, on the 284 frame, size has been reduced 35%, although NEMA mounting dimensions have been maintained . . . starting torques are as much as 134% greater per pound of motor . . . maximum torques as much as 116% more per pound.

Electrical characteristics have been improved . . . new materials and new winding techniques give increased protection against electrical failure. And sealed, pre-lubricated bearings do away with need for greasing or attention for at least five years!

The Life-Line Motor, as a result, represents the biggest single step forward in design and construction since the invention of the electric motor 58 years ago. Life-Line Motors are now reaching the drives of industry by the thousands, but are not yet available in quantities to meet the unprecedented demand. So, look over Life-Line advantages now with an eye to your future requirements. Your local Westinghouse office can give you full details, or write to Westinghouse Electric Corporation, P. O. Box 2025, Buffalo 5, N. Y.

★ ★ ★

Life-Line Motors are now in production at the new Westinghouse Motor Works in Buffalo, N. Y. This plant is laid out, tooled and equipped to fully utilize newly developed production processes and techniques on a scale hitherto unequalled in the manufacture of electrical motors.

J-21406

LESS SPACE PER HP. Life-Line Motors occupy less space per horsepower than any other standard motor . . . making it easier to build into machines and install in cramped quarters.

MORE TORQUE PER LB. Life-Line Motors give as much as 134% higher starting torque per pound of motor . . . up to 116% higher maximum torque.

1947
1948
1949
1950
1951

NO LUBRICATION FOR 5 YEARS. Life-Line Motors need no greasing for AT LEAST FIVE YEARS. Bearings are pre-lubricated . . . sealed against dirt and moisture.

IMPROVED WINDINGS. New insulating materials . . . new coil winding techniques . . . new stator slot designs . . . give the Life-Line new record-setting protection against electrical failures.

NEW QUIET SMOOTHNESS. Life-Line Motors cut vibration and noise to new low limits for standard motors . . . satisfy many "special motor" requirements.

NEW SLEEK LINES. The Life-Line has sleek lines . . . a smooth finish . . . discourages dust and dirt accumulations . . . harmonizes with modern machine and tool design.

Life-Line motors

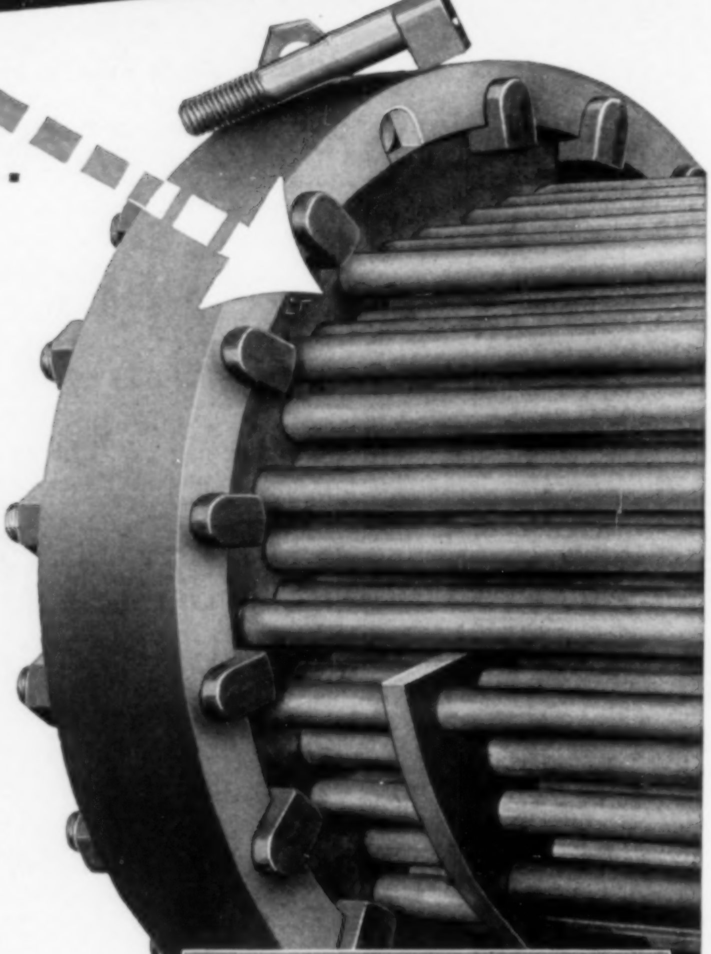
NO LEAKS HERE

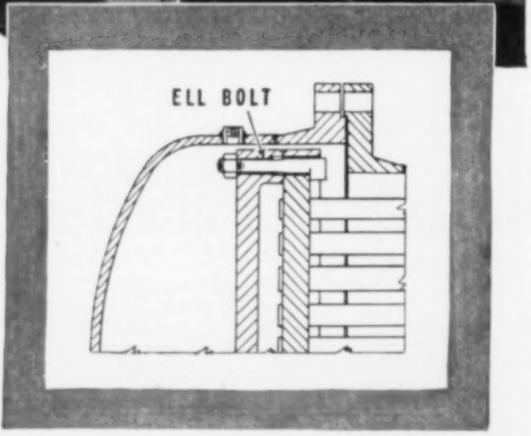
with the patented . . .

Vogt

ELL BOLT CONSTRUCTION

of Floating Tube Sheet Assembly





●

YOU LOSE when an exchanger leaks . . . with the possibility of fluid contamination, or frequent shutdowns for repairs.

None of these evils need plague you when you employ the Vogt patented floating tube sheet assembly because there is no distortion of a split ring to worry about in making up the joint time after time. It's easy to make tight and it stays tight!

HEAT TRANSFER EQUIPMENT
by Vogt

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for a copy on your letterhead.

Patent Nos.
1,895,735
2,232,478

HENRY VOGT MACHINE CO. INC. • LOUISVILLE 10, KY.
Branch Offices. New York, Philadelphia, Cleveland, Chicago, St Louis, Dallas

Vogt HEAT TRANSFER EQUIPMENT

ONE-MAN RIVETING TEAM FOR SHEET METAL WORK

Capacities range from 1/8″ to 7/16″ size rivets.

The I-R AIR-BUCK RIVETER

Only one operator is required for riveting operations when the Air-Buck Riveter is used. *By means of a yoke, this tool does its own bucking up.* In addition, it further simplifies the riveting operation by driving the driven head to a predetermined height, which is adjustable. It automatically shuts off when this height is reached.

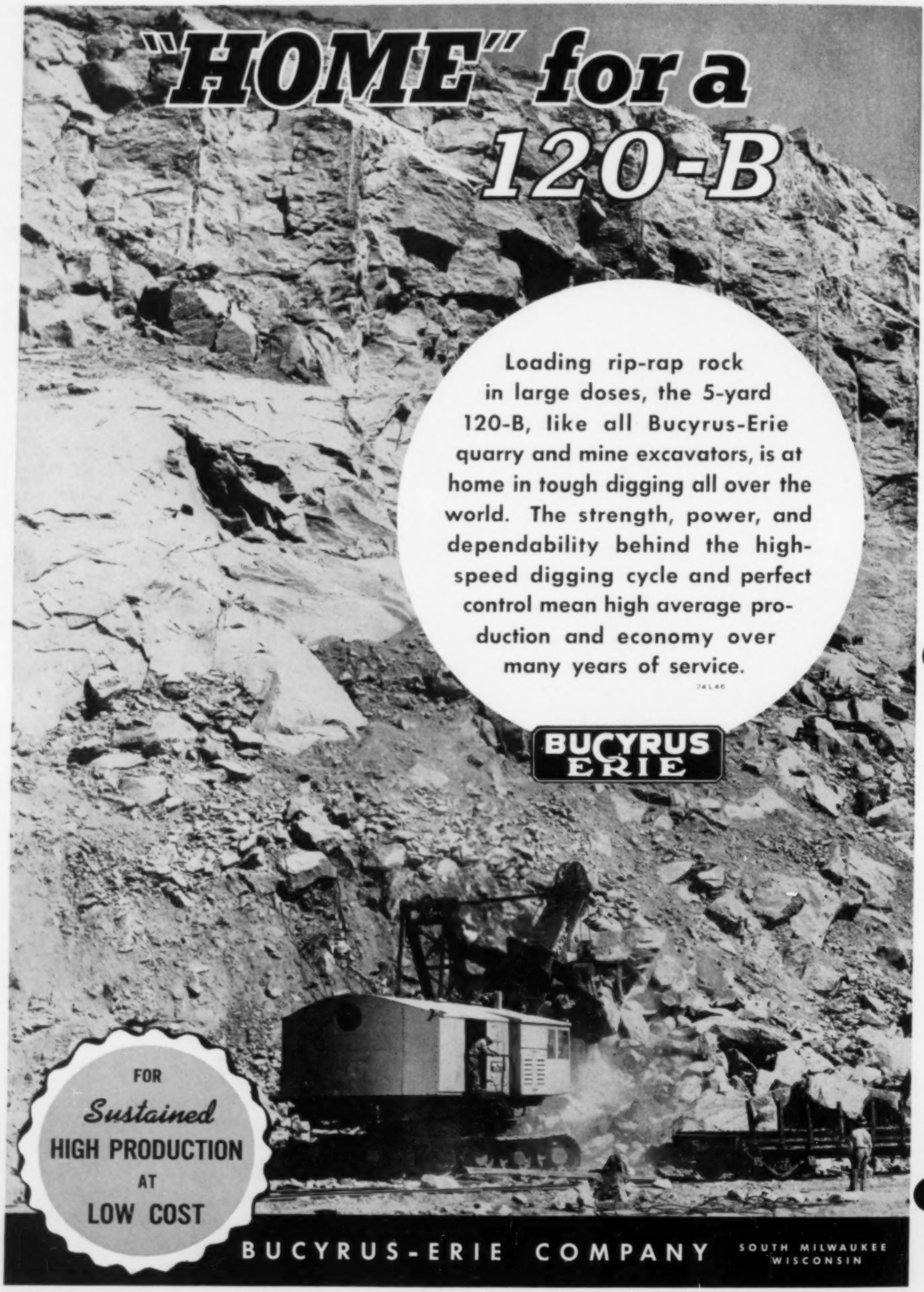
Consider these other Air-Buck advantages:

- Minimum of experience needed to produce perfect riveting.
- Riveting cycle can be completed or interrupted as desired.
- Inspection period permits alignment of rivet in hole.
- Extra clearance instantly available for passing over ribs.
- Easy to hold—recoil of the hammer is transmitted through the yoke and helps to buck up the rivet.
- Wastes no air. All air is utilized for doing work.
- Yokes of different sizes are easily interchanged.
- Lighter and smaller than other yoke-type riveters of similar capacity.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

8-949



"HOME" for a 120-B

Loading rip-rap rock in large doses, the 5-yard 120-B, like all Bucyrus-Erie quarry and mine excavators, is at home in tough digging all over the world. The strength, power, and dependability behind the high-speed digging cycle and perfect control mean high average production and economy over many years of service.

24L46

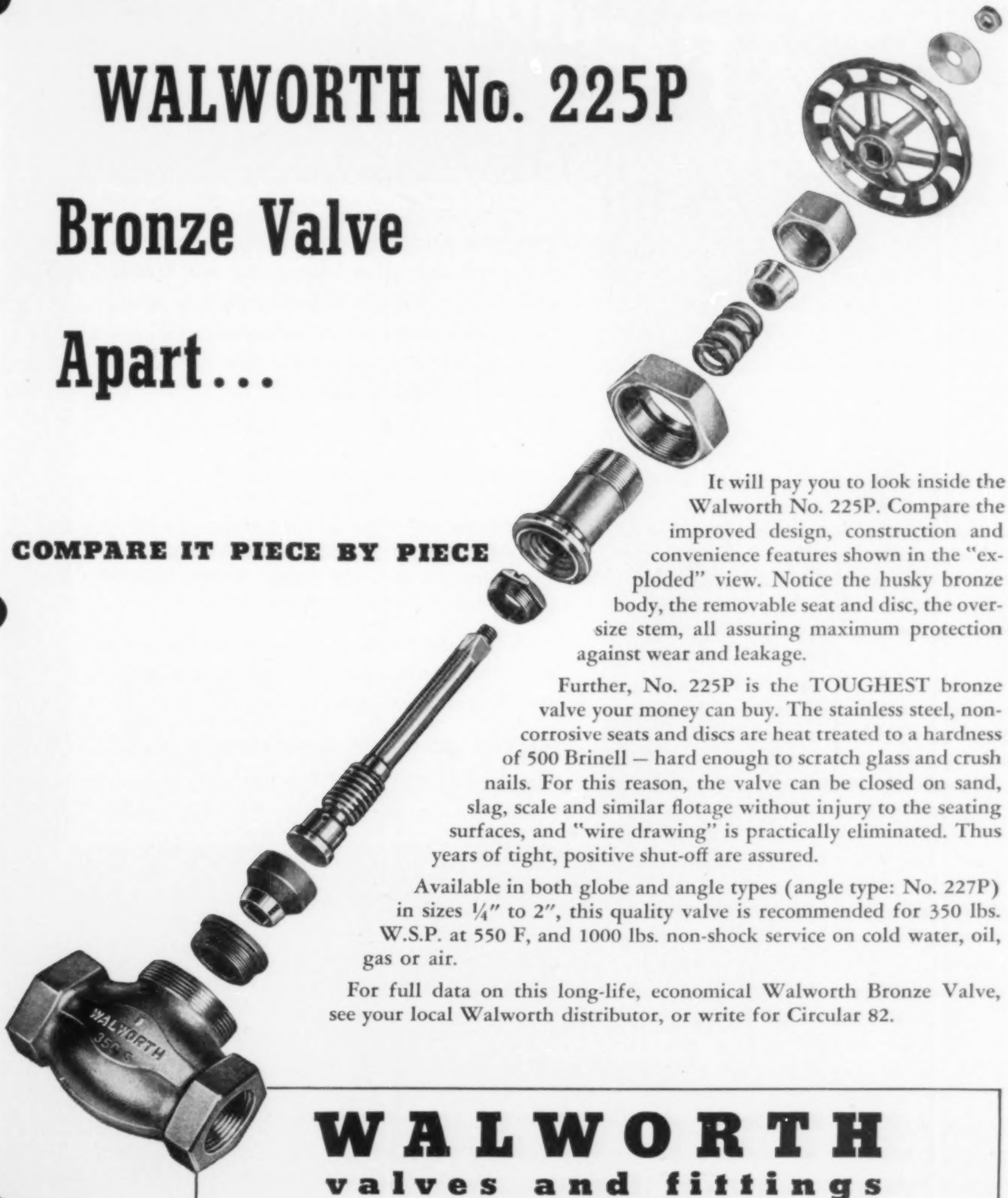
BUCYRUS ERIE

FOR
Sustained
HIGH PRODUCTION
AT
LOW COST

BUCYRUS-ERIE COMPANY

SOUTH MILWAUKEE
WISCONSIN

Take a
WALWORTH No. 225P
Bronze Valve
Apart...



COMPARE IT PIECE BY PIECE

It will pay you to look inside the Walworth No. 225P. Compare the improved design, construction and convenience features shown in the "exploded" view. Notice the husky bronze body, the removable seat and disc, the oversize stem, all assuring maximum protection against wear and leakage.

Further, No. 225P is the TOUGHEST bronze valve your money can buy. The stainless steel, noncorrosive seats and discs are heat treated to a hardness of 500 Brinell — hard enough to scratch glass and crush nails. For this reason, the valve can be closed on sand, slag, scale and similar flotage without injury to the seating surfaces, and "wire drawing" is practically eliminated. Thus years of tight, positive shut-off are assured.

Available in both globe and angle types (angle type: No. 227P) in sizes ¼″ to 2″, this quality valve is recommended for 350 lbs. W.S.P. at 550 F, and 1000 lbs. non-shock service on cold water, oil, gas or air.

For full data on this long-life, economical Walworth Bronze Valve, see your local Walworth distributor, or write for Circular 82.

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Now . . . B-7 Resinoid Bond!

Another New Norton Development for the Foundry

THE same advantages of a fast cutting action plus long life which have made Norton B-5 Resinoid Wheels so outstandingly popular in the soft grades are now made available in the hard grades by the new B-7 resinoid bond. A stronger and more heat-resistant bond, it is showing remarkable cost cutting ability on swing frames, floor stands and portable grinders.

Available with the Sensational New 32 ALUNDUM Abrasive

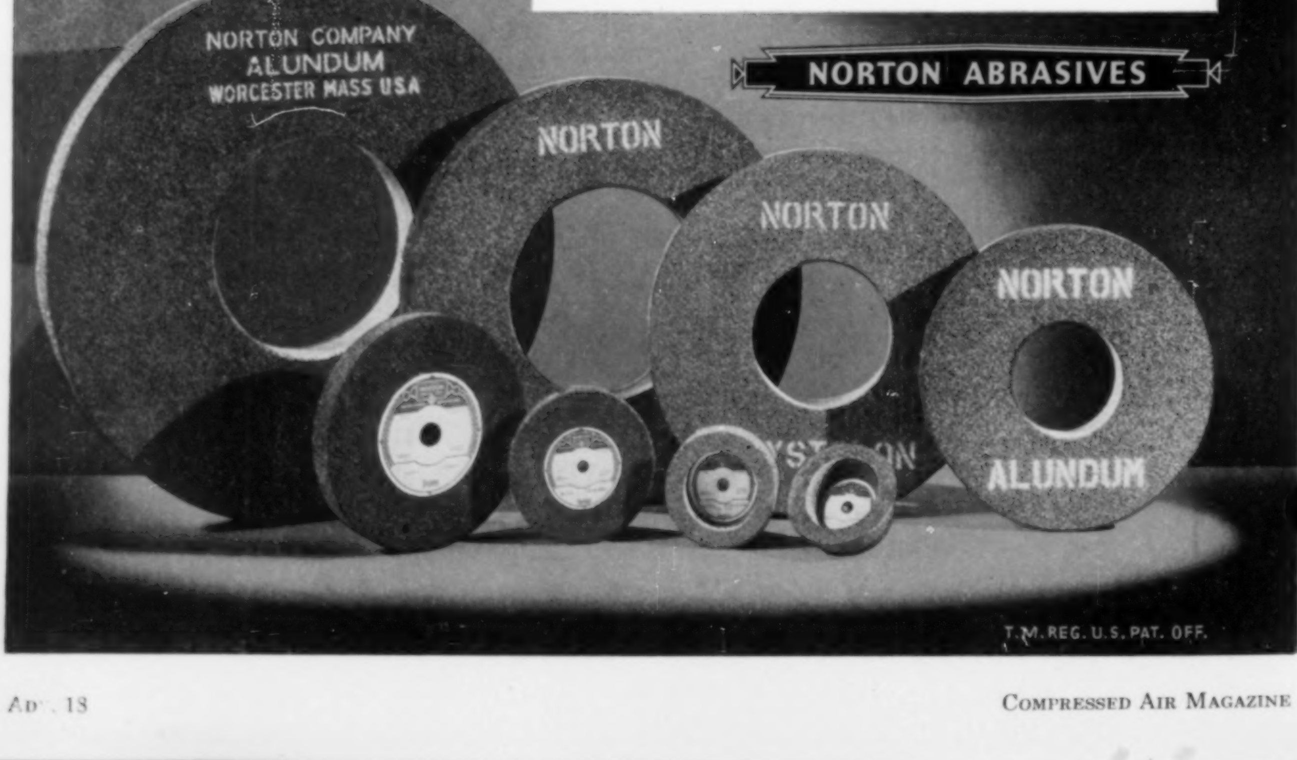
B-7 Resinoid Bond can be furnished with the fast cutting new 32 ALUNDUM abrasive as well as the other Norton abrasives—ALUNDUM, 57 ALUNDUM and CRYSTOLON.

It will definitely pay you to use either the Norton B-5 or B-7 Resinoid Bonds. Let a Norton abrasive engineer select the right one for each of your jobs.

NORTON COMPANY, WORCESTER 6, MASS.
Distributors in All Principal Cities

W-1084

NORTON ABRASIVES



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Compressed Air Magazine

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VOLUME 52 **January, 1947** NUMBER 1

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A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit

Published by Compressed Air Magazine Co., G. W. Morrison, *President*; C. H. Vivian, *Vice-President*; J. W. Young, *Secretary-Treasurer*.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York 4, N. Y., L. H. Geyer, *Representative*.
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.

ON THE COVER

WARTIME construction projects could not find time to compromise with the weather. They had to be rushed to completion, and some of them had to cope with harsh climatic conditions. Much of the rock drilling connected with the huge Shipshaw power development in Canada was done during the winter of 1942-43 when subzero temperatures prevailed for weeks at a stretch. Special steps were taken to prevent freezing of the moisture in compressed-air supply lines and the workers adopted Arctic attire to protect them from the icy winds. Our cover picture shows a drill runner looking up at a bleak sky as he started for his working place on a frigid morning. On his shoulder is a sinker drill, a heavy drifter-type machine equipped with handles to adapt it for use in shaft-sinking work.

●

IN THIS ISSUE

IN OUR April, May, and December issues of last year, W. M. Goodwin described the tremendous hydroelectric power resources of the Canadian Province of Quebec and pointed out their significance in connection with wartime and peacetime industrial activities. In this issue, he rounds out the series with an article devoted to the construction of the outstanding Shipshaw No. 2 power development. Although it was a colossal job it was cloaked in military secrecy at the time and has been given little publicity even since the war ended.

●

SHAFT sinking is a highly specialized mining operation that has often been described but never very well illustrated because it is difficult to obtain good photographs under the conditions that exist. Through the courtesy of South African mining interests we are privileged to present a sequential pictorial story of the sinking of a large circular-section ventilating shaft at one of the West Rand gold mines. The pictures were taken for educational purposes and have not been previously published.

●

MOST of our readers are familiar with the diversified uses made of compressed-air equipment in developing hydroelectric projects. Few of them, however, are probably aware that compressed air also performs numerous services in connection with the operation of the finished plants. The article starting on page thirteen deals with the various applications of air in and around the waterpower generating stations of the Tennessee Valley Authority.

Constructing the Shipshaw Power Development

W. M. Goodwin

THE latest of Canada's large hydroelectric developments to be completed, Shipshaw No. 2 on the Saguenay River in northern Quebec, represents one of the heaviest rock-excavation jobs done in recent years. Because of its wartime significance, the project was cloaked in secrecy, but the principal contractor, Foundation Company of Canada, Limited, kept a full record of the work that makes an interesting story for those who follow the performances of modern rock drills. Three types of drilling machines were used—namely, deep-well percussion drills, various kinds of hammer drills, and diamond drills—and rock excavating involved open-cut work, shaft sinking, and tunnel driving. In the description that follows, the construction plan will be outlined first, and then some details will be given of the drilling record. (A general layout of the undertaking is illustrated on page 4.)

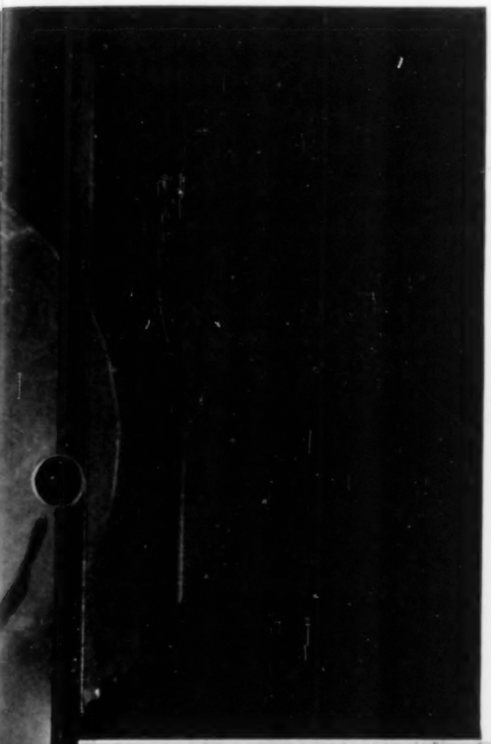
Shipshaw No. 2 Powerhouse contains twelve generating units with a combined capacity of 1,200,000 hp. At present, the minimum flow of the Saguenay River is 42,500 cubic feet per second, and this is diverted through a canal, 7500 feet long, to a headblock situated on a ridge of rock. Six shafts sunk in this rock formation are connected with six horizontal tunnels driven from the foot of the ridge at the level of the turbines. The normal head is 208 feet. The tailrace is at tidewater level. In brief, the project constitutes a 10,000-foot-long by-pass at the end of which the water of this sizable stream is carried through a building that houses the largest power installation placed to date under one roof.

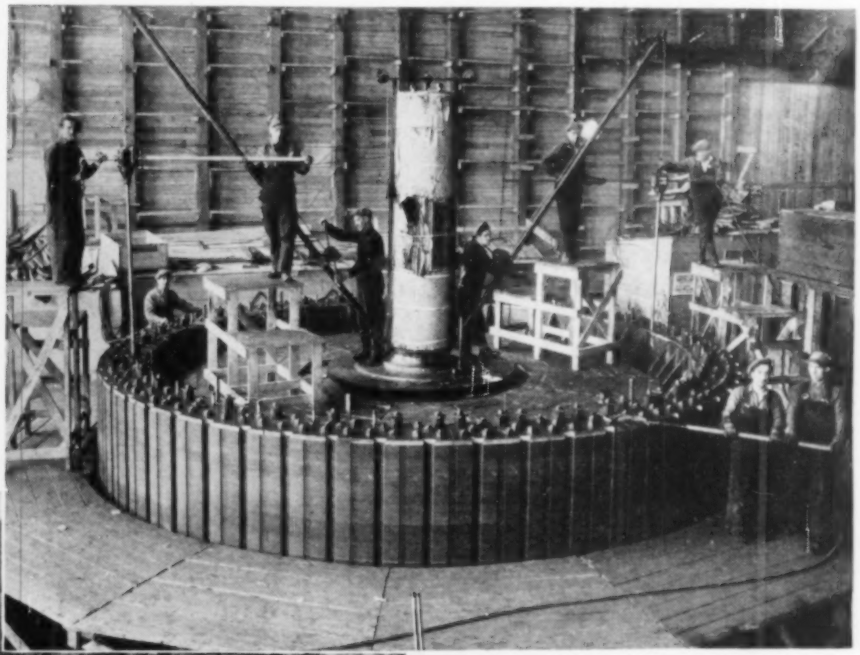
The original contract provided for the construction of but one-half of the power plant and, consequently, of three instead of six shafts and tunnels, the plan being to set up only six of the generating units. The schedule drawn up at that time called for the delivery of power from the first unit by January 1, 1943, and from the second by February 15, following. In the spring of 1942, when work had been underway a year, it was found that one of the two generator suppliers could furnish a unit before the date on which it had been promised, and the time it was scheduled to go into operation was accordingly advanced to November 20, 1942, or 40 days ahead of the date previously set. Actually, this revised timetable was adhered to within four days: the first generator went on the line on November 24, and the second one three days later. Only eighteen months had elapsed since the contractor had been given authority to proceed. The remaining units were set up and started and all phases of the job completed within another year, or in a total elapsed period of 30 months.

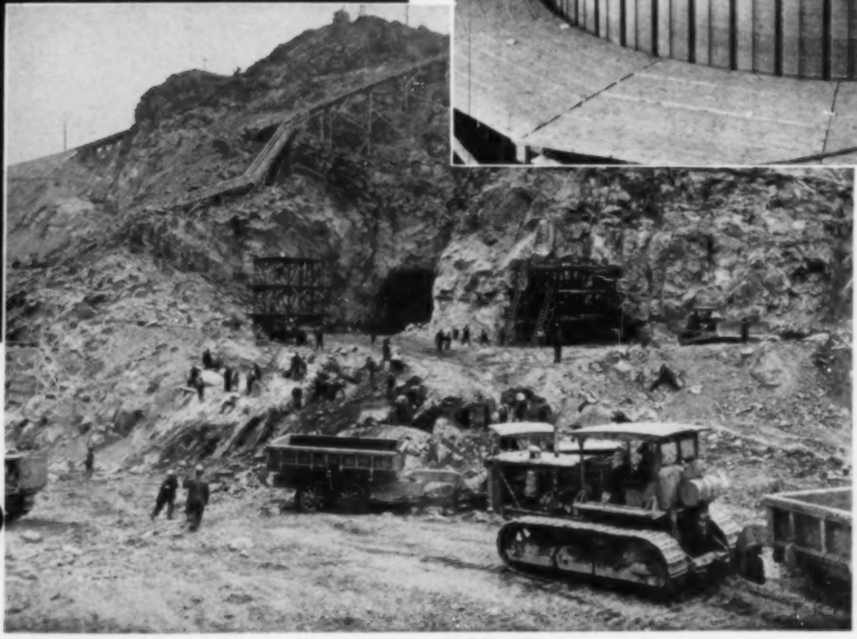
Preliminary work that had to be done before actual construction could attain full speed was in itself of great magnitude. The site had to be cleared, railroads and highways run to all parts of it, a town had to be built and completely equipped, and all shops, offices, and supply depots erected and outfitted. Living accommodations of various kinds were provided for a total of 3900 workmen. Four separate dining rooms seating 2740 were established in addition to a staff dining room that accommodated 156 persons. A recreation building contained ample facilities for entertainment, including a 600-seat auditorium where motion pictures were shown during the week and Protestant and Catholic church services were conducted on Sundays. Two switchboards and 55 miles of wire served the 185 telephones around the job. As many as 200 trucks were engaged in transporting men and materials, and eight locomotives took care of the yard railroad service. The average daily employment was 3960, and a daily peak of 9863 was reached in June, 1942. The mechanical department numbered 750 men at one time. All told, 47,747 persons were hired during the life of the job.

Shipshaw No. 2 hydraulic works, the last of three steps in the development of 2,000,000 installed horsepower on the Saguenay River, was rushed to completion in order to supply energy for the greatly expanded aluminum reduction plant close by at Arvida, the largest single works of its kind in the world, and the smaller one at Isle Maligne 20 miles away. The huge airplane-production program in Great Britain depended essentially upon the success of these aluminum reduction plants in meeting its schedules. No expense or effort was spared to bring the powerhouse into operation at the appointed time. All objectives were attained virtually as planned, and soon hydroelectric energy from the new 100,000-hp. generators was represented in the fleets of Lancasters over Germany and in the Spitfires that guarded the English Channel. And in spite of all this urgency and speed, the unit construction costs were kept at a moderate figure. Efficient drilling contributed its share to this record of economy.

The hydraulic works included the removal of 5,895,000 cubic yards of material: 3,265,000 cubic yards of earth and

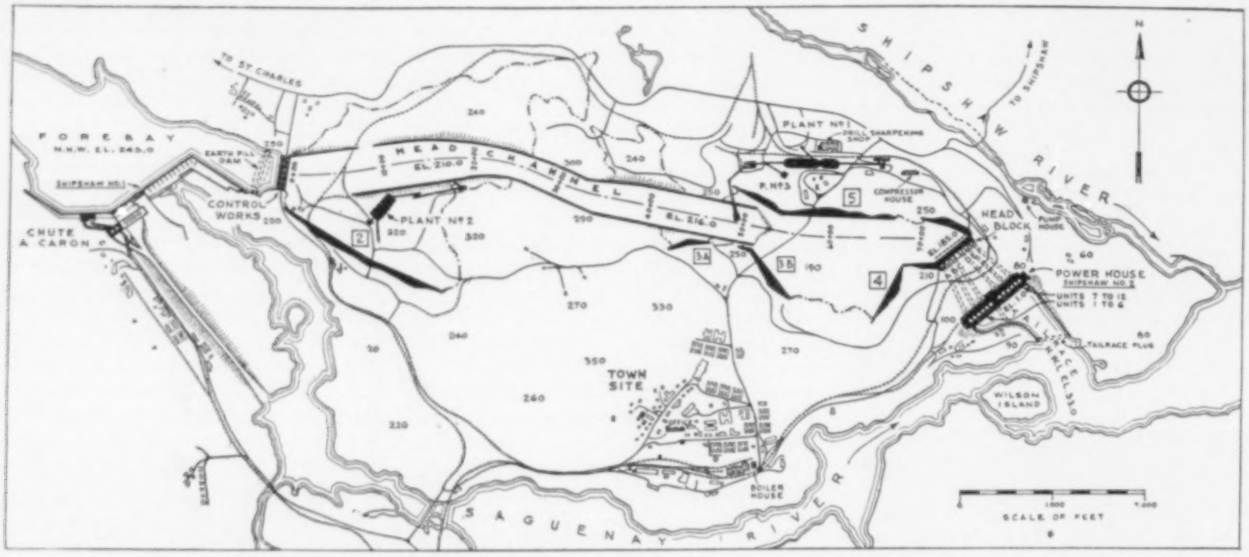






SHIPSHAW SCENES

A stretch of the head channel, where it was excavated in rock to a maximum depth of 105 feet, is shown nearly completed at the top-left. With power for more aluminum vitally needed, operations went on around the clock. Below the article heading is a night-time drilling scene, with wagon drills above and Jackhamers below. The downstream portal of one of the six 34-foot-diameter power tunnels is at the left. The drill carriage or jumbo is at the right in the picture, and truck-mounted timber staging for loading drill holes with explosives at the left. Compressed air contributed to the work in many ways. In the powerhouse (above) pneumatic tools expedited assembly of the 100,000-hp. generators. Men look like pygmies inside one of the finished penstock tunnels (center).


TO ST. CHARLES
FOREBAY
M.H.W. EL. 245.0
EARTH FILL DAM
SHIPSHAW NO. 1
CONTROL WORKS
CHUTE A CARON
HEAD CHANNEL
EL. 210.0
EL. 216.0
PLANT Nº 2
PLANT Nº 1
DRILL SHARPENING SHOP
P. Nº 3
COMPRESSOR HOUSE
2
3A
3B
4
5
240
250
290
300
320
270
330
350
260
220
190
210
100
90
80
60
TOWN SITE
BOILER HOUSE
HEAD BLOCK
EL. 185.0
PUMP HOUSE
POWER HOUSE
SHIPSHAW NO. 2
UNITS 7 TO 12
UNITS 1 TO 6
TAILRACE
TAILRACE PLUG
WILSON ISLAND
SHIPSHAW RIVER
TO SHIPSHAW
SAGUENAY RIVER
N
0
1000
2000
SCALE OF FEET

GENERAL LAYOUT OF DEVELOPMENT AREA

Preliminary operations included clearing 430 acres of land, building 16 miles of roads and 17 miles of railroads to serve all working areas, providing a town site with offices and living accommodations, and setting up shops, compressor plants, warehouses, and other needed structures. The average daily employment totaled 3960 and the peak 9863.

2,630,000 cubic yards of rock. The latter was anorthosite, composed mainly of the mineral feldspar, which drilled a little more easily than granite and broke readily into angular blocks. This material furnished the coarse aggregate for the concrete and was well suited for that purpose.

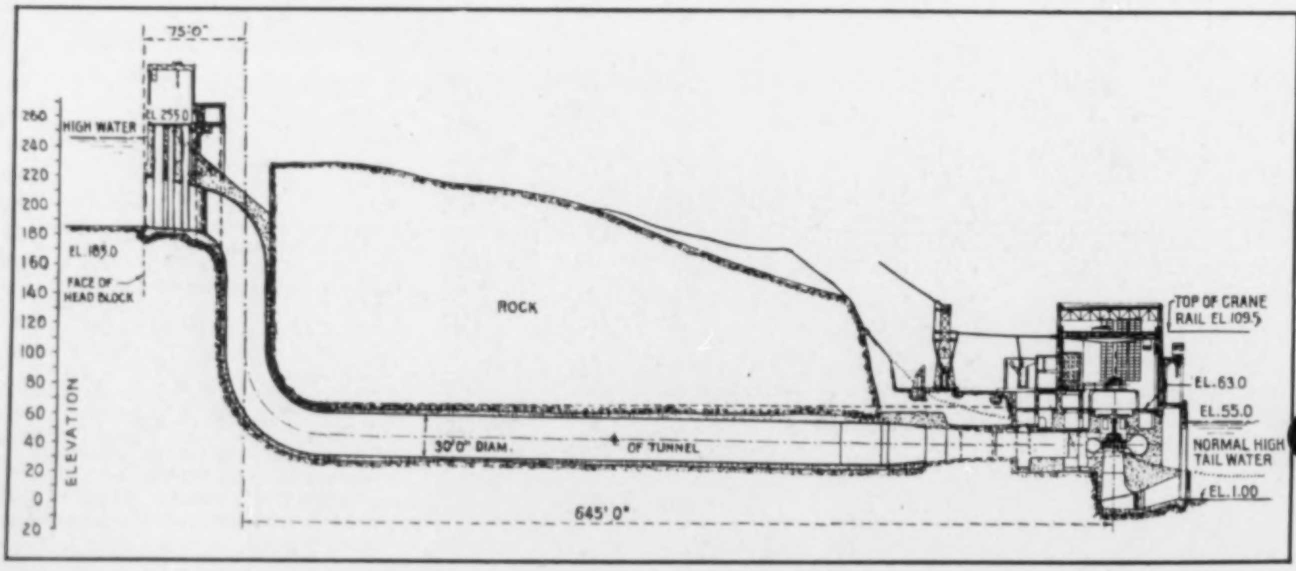
By far the larger part of all the excavating in rock was confined to the canal—to an open cut 300 feet in width and 105 feet maximum depth. The six shafts with their associate tunnels accounted for only 34,000 and 110,000 cubic yards, respectively. The headblock required comparatively little rock removal, as did the substructure of the power station and the entrance to the tunnels. The canal extends mostly through earth and gravel, while the excavation for the tailrace, like the power plant, was largely in gravel, with a convenient barrier of solid rock along the river bank behind which operations could proceed "in the dry."

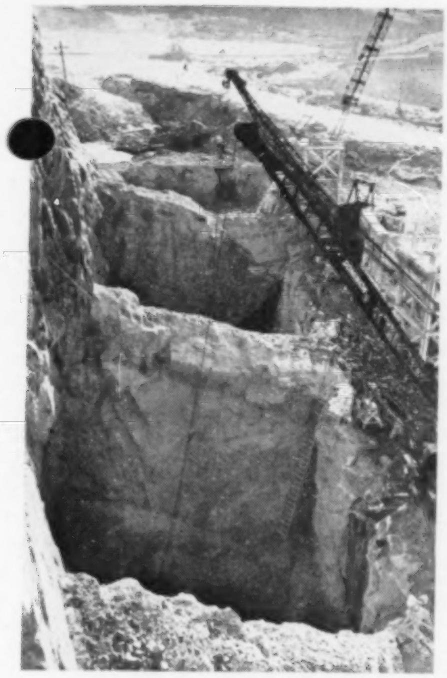
Churn drills, wagon drills, and Jackhamers were used for the open-cut work; the six 34-foot-diameter shafts, some of which are shown in an accompanying picture, were drilled with the usual sinkers; and the associate tunnels were driven with power-feed drifters mounted on jumbos. Each of these types of excavation will be discussed in turn; but first will be given a brief description of the compressed-air plant and the drill-sharpening equipment on the job.

The rock-drill and air requirements were computed in advance of the work by making a detailed study of the excavating that would have to be done in each area. The number of lineal feet of drilling per cubic yard of rock was estimated, as well as the total amount of drilling involved. The over-all allotted drilling time was set at 212 days, with two 10-hour drilling shifts per day, and schedules for each area were drawn up accordingly. Drilling capacities of the various types of drills that were to be used were then figured out based on Canadian Ingersoll-Rand equipment. When all this information had been

TYPICAL CROSS SECTION THROUGH POWER-PLANT AREA

The tailrace is at tidewater level and the plant operates under a normal head of 208 feet. The minimum flow of the river is 42,500 second-feet.


75'0"
260
240
220
200
180
160
140
120
100
80
60
40
20
0
20
ELEVATION
HIGH WATER
EL. 255.0
EL. 185.0
FACE OF HEAD BLOCK
ROCK
30'0" DIAM. OF TUNNEL
645' 0"
TOP OF CRANE RAIL EL. 109.5
EL. 63.0
EL. 55.0
NORMAL HIGH TAIL WATER
EL. 1.00



SINKING SHAFTS

In sinking three of the six shafts leading to the power tunnels, headframes were erected and conventional mining procedure was followed. In the case of the three others pictured here, the rock was fractured and a different method had to be adopted. The shafts were carried down full size to safe depths, using headframes, and immediately lined with concrete. Pilot shafts, 8x10 feet, were then sunk to tunnel grade, with crawler cranes serving the operations. Later the small openings were enlarged to full size, the muck being dropped down to tunnel level where it was loaded with power shovels.

gathered, it was possible to compute the average daily drilling footage that would have to be maintained to meet the schedule and also to estimate closely the number of drills and the compressor capacity that would have to be provided. An indication of the intensity of the program can be gained from the fact that 124 drifter and sinker drills, 38 wagon drills, and 98 hand-held drills of the Jackhamer type were employed, together with 39 well drills and several diamond drills. Approximately 600,000 pounds of drill steel and 3,360,000 pounds of dynamite were consumed.

The main compressor plant was located near the large rock cut on the canal line. It was made up of seven Canadian Ingersoll-Rand synchronous-motor-driven machines with a combined capacity of 23,310 cfm. An additional 8000 cfm. was supplied by sixteen portable and semiportable units placed at convenient points. The air-distribution system had a length of 33,400 feet, or more than 6 miles, and consisted of steel pipe ranging in diameter from 12 to 3 inches. Most of it was welded at the joints. Pressure in the mains was kept at 100 pounds. During the winter months, Tanner gas was used to counteract the effect of moisture in the air and proved very effective.

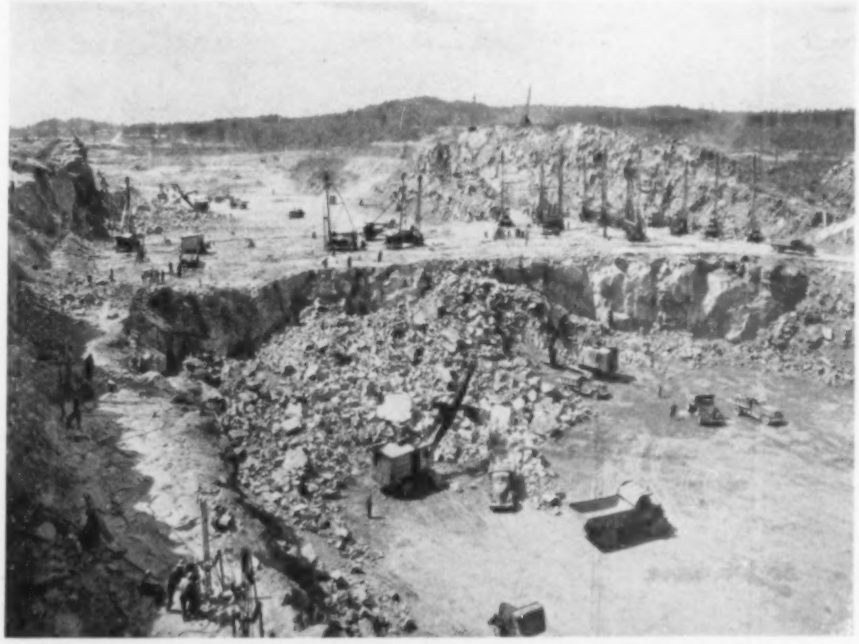
The hammer-drill steel was sharpened in a central plant, which contained thirteen 27-F oil furnaces, thirteen 550-B drill sharpeners, two No. 34 sharpeners, and the necessary shank and bit punches, shank grinders, and pedestal grinders. This shop handled an average of 12,000 steels a day, or 40 per hour per sharpener, in addition to the well-drill bits, which were reconditioned by two Bucyrus-Erie and two Gill dressers.

More than two-thirds of the rock excavation on the entire project was in the cut in the upstream half of the canal. As the benches there were normally about 40 feet high, a third lift was necessary in the central part where the maximum cut was 105 feet deep. The bulk of the drilling on these benches was done with the well drills, which were assigned to cuts exceeding 18 feet in depth and put in 6-inch holes at intervals of 8 to 10 feet. Well drills also did some of the line drilling along the sides of the canal, the holes being spaced 3 to 5 feet apart, but most of it was done with the air-operated wagon drills working on 12-inch centers.

For cuts from 8 to 18 feet in depth the contractor utilized wagon drills, the holes being spaced at intervals of from 3 to 5 feet, as required. These FM-2's used 1¼-inch steel with starting bits 2⅝ inches in diameter and with a reduction of ⅛ inch for each 2-foot run. To insure a canal with a level bed, toe holes were put in by the wagon drills at the bottom of the cut. Sinkers—N-82's—equipped with the same type of steel as the wagon drills, served for the shallow parts of the cut, while Jackhamers did the blockholing and trimming, using 1-inch steel up to 8 feet long with 2-inch starter bits.

No heavy rock work was involved in excavating the foundations for the control works, for the five concrete dams along the canal, or for the wing walls of the headblock, the weathered or frost-cracked rock being not more than 5 feet deep. Under the north wing wall, however, there was a narrow fault filled with a claylike and shattered material that had to be removed to a depth of 32 feet to insure against leakage.

Apart from the trimming required to start the six shafts and tunnels, the only other major rock work was in connection with the foundation for the power plant and the tailrace. As noted before, by far the larger part of the excavating in this area (1,200,000 cubic yards) was in gravel. There was just about enough rock under the powerhouse site for the requirements of that structure and to insure solid material in the ends of the tunnels to serve as anchorages for the steel penstocks leading to the turbines. In the case of the tailrace, drilling was confined to the narrow section adjoining the river where it facilitated operations to have a rock dam to keep the water out and thus permit excavating "in the dry," as has already been mentioned.

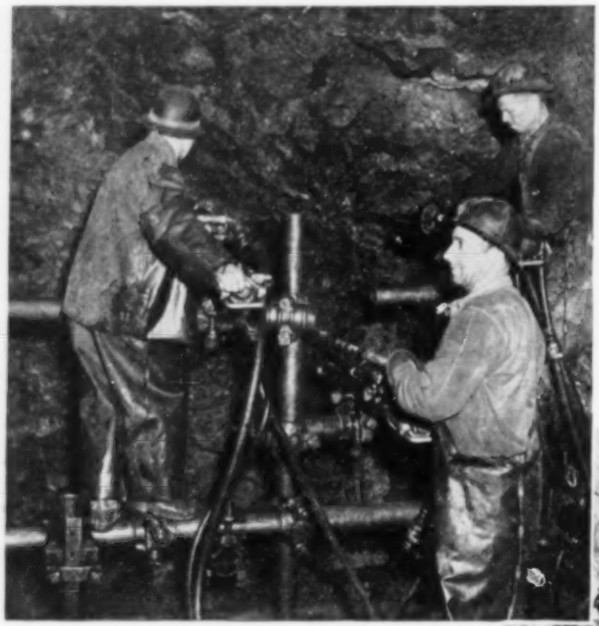


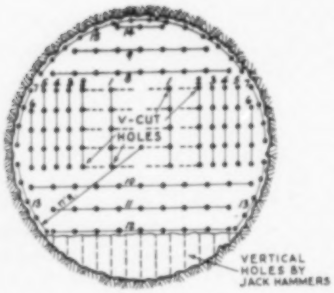
EXCAVATING HEAD CHANNEL

More than 1,600,000 cubic yards of rock had to be removed in excavating the channel to carry water from the control works to the headblock where the penstocks start. The canal is 7500 feet long and has a minimum width of 500 feet in earth and 300 feet in rock. This view shows one of the 40-foot benches in the central section, where the maximum cut was made.

TUNNEL-DRILLING DIAGRAMS

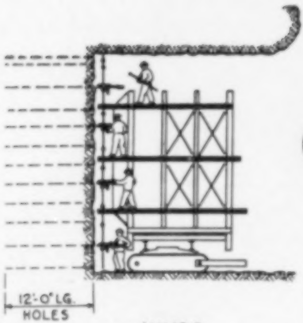
The combined length of the six tunnels is 2560 feet. The breaking of a round of 11½ feet required the drilling of 1680 feet of horizontal holes. In addition, vertical holes were put down in the invert, as indicated at the right.




V-CUT HOLES
VERTICAL HOLES BY JACK HAMMERS

DRILLING DIAGRAM

NUMBERS INDICATE FIRING ORDER ———
NUMBER OF HOLES PER ROUND ——— 140
DEPTH OF STRAIGHT HOLES ——— 12'-0"
DEPTH OF V-CUT HOLES ——— 8'-0" TO 15'-0"
SIZE OF HOLES ——— 2"Φ DOWN TO 1⅝"Φ
DEPTH OF ROUND PULLED ——— 11'-6"
LBS. OF DYNAMITE (60%) PER C.Y. OF ROCK — 3.5
LOADING AND SHOOTING TIME ——— 1 HR.-15 M

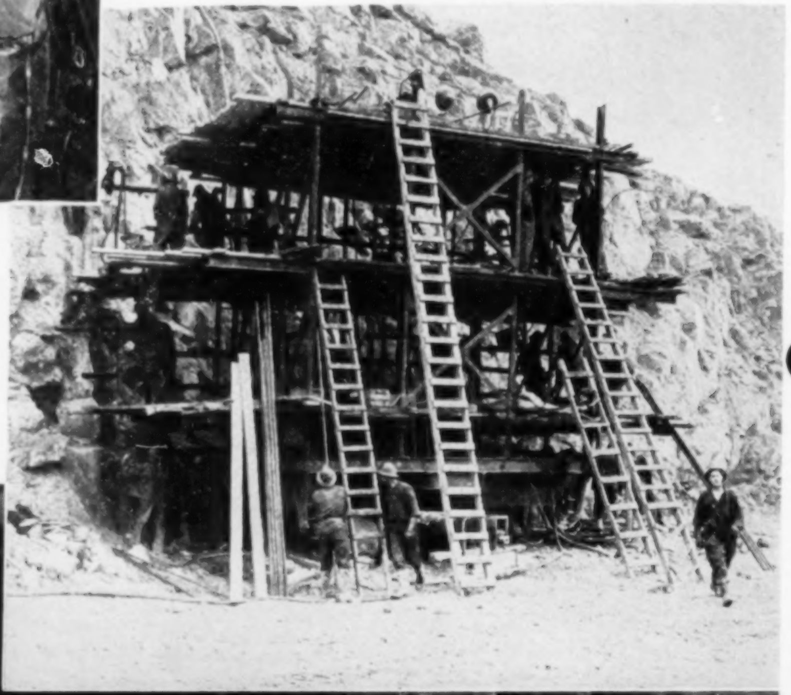


JUMBO

NUMBER OF DRILLS (C.I.R. Nº 82 DRIFTERS)-24
RATE PER HOUR PER DRILL ——— 25'-4"
NO. OF HOLES PER DRILL PER SHIFT ——— 6
LENGTH OF STEELS ——— 2'. 4'. 6'. 8'. 10'. 12' & 15'
LENGTH USED PER SHARPENING ——— 2'-0"
NO. OF SETS OF STEEL PER HOLE ——— 1
KIND OF DRILLING ——— WET
DRILLING TIME PER ROUND ——— 3 HRS.

TUNNEL DRIVING

Three-platform drill carriages or jumbos (right) mounted on tractors each carried 24 Canadian Ingersoll-Rand power-feed drifters at the front. A close view of two of the drills at work is shown above. After blasting, muck was loaded by a 1¾-cubic-yard Marion electric shovel (below) into tractor-drawn Athey wagons.



IT GOT COLD

Winter failed to slow down the construction schedule. Dressed for January, two youths are shown using a paving breaker to clear away an accumulation of ice.

Drilling for the powerhouse foundation was done with FM-2 wagon drills and N-82 sinkers, while most of the excavating on the rock bank of the Saguenay was done in two lifts with well drills and by methods similar to those used in the case of the canal. Line drilling of the tailrace walls was done with diamond drills. For depths up to 20 feet the holes were on 1-foot centers and were not loaded; for depths from 20 to 100 feet they were 3 feet apart and loaded.

A rather unusual plan was adopted for the removal of the rock dam or plug that held the river back until the tailrace and powerhouse foundations were completed and the power plant was built. In order to blast it away instantaneously, vertical and sloping drill holes were put in, supplemented by twelve short drifts for coyote charges at the base. Most of the down holes were drilled with diamond drills generally on 5-foot centers, while the coyote holes were spaced 25 feet apart. In the tailrace area behind the dam was excavated a trench 40 feet wide to a depth of 10 feet below final grade to receive the rock from the blast. It provided space for approximately 13,000 cubic yards, while the plug contained 18,000 cubic yards. On November 17, 1942, a crew that averaged 80 men began placing 81,750 pounds of dynamite in the holes and finished the work on the nineteenth. The holes were connected with 26,800 feet of primacord detonating fuse and the shot was fired on the twenty-first. Five days later the first generating unit was in operation!

All the types of drills on the job made very good records, the average footage per hour being: FM-2 wagon drills, 16 feet; N-82 sinkers, 8 feet; Jackhamers, 6 to 8 feet; well drills, 1½ to 2 feet; and diamond drills, 2 feet. With the exception of the final blast in the tailrace dam, the dynamite used on the open-cut work averaged 1 pound per cubic yard of rock. Well-drill holes were loaded with 75 percent dynamite; others, with 60 percent.

Underground excavating in shafts and tunnels presented no unusual features. The work was executed on a subcontract by a mining contractor, Patrick Harrison, of Montreal, Que. Three of the shafts in solid ground were equipped with timber headframes and were sunk the full diameter, 34 feet to final depth, in the usual manner. N-82 sinkers were used and muck was hoisted in 2-ton buckets. The rock penetrated by the three other shafts was somewhat fractured, so a different method had to be followed. The top part of each was sunk full diameter a short distance and then collared with a permanent concrete lining. Then a pilot shaft, 10x12-feet in section, was carried down and slashed full size into the tunnel after the connection had been made. These three shafts were served by crawler cranes.

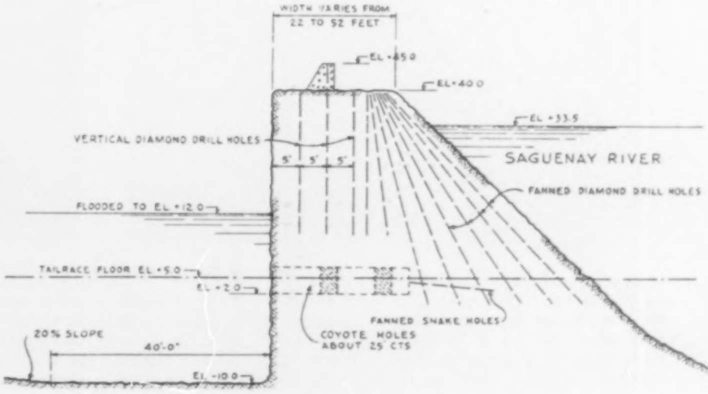
The six tunnels, which averaged 427 feet in length, were drilled from a carriage or jumbo, and the blasted material was loaded with 1¾-yard electric shovels into 10-ton wagons drawn by tractors. A small invert was left in place to provide a level haulageway and was removed later by putting in vertical holes with Jackhamers. The jumbo had a steel framework with three timber platforms that made it possible to reach the full height of the tunnels. It was set on a caterpillar trailer and was moved in and out by a tractor. To give access to the sides of a bore, removable extensions were put in place when drilling. Twenty-four Canadian Ingersoll-Rand N-82 power-feed drifter drills were mounted on the front of the carriage and each on a universal column arm to permit swinging it, as desired. When on its way to the working face, the jumbo carried 50 sets of steel and weighed 23 tons, exclusive of its chassis. There were four rows of drills, six to a row, with a boss in charge of each and a foreman over all. In addition to these supervisors, there was a crew numbering 24 drill runners and eight helpers.

After a round had been drilled, the jumbo was hauled out of the tunnel and a truck-mounted timber framework with three platforms was brought in for loading the holes with explosive. Following a blast, air was blown for 30 minutes through a 30-inch duct that extended to within 75 feet of the heading. Mucking followed, and after that the drill carriage was again moved in for scaling loose rock from the walls and roof and for drilling the next round.

A round consisted of 140 holes, most of them 12 feet deep, with cut holes up to 15 feet. Each machine drilled an average of 23 feet 4 inches per hour. One jumbo served for all the drilling, but at times when two tunnels were worked simultaneously it alternated between them. The average advance per round was 11½ feet, and the cycle of operations was completed in eighteen hours, divided as follows: surveying, 1 hour; drilling and moving jumbo in and out, 4 hours; loading and blasting, 1¼ hours; ventilating, ½ hour; scaling loose rock, 2¼ hours; mucking, 9 hours. Progress made in 24 hours averaged 13.4 feet when only one face was being worked, and 30 feet when two headings were being advanced. The shafts and tunnels accounted for 144,000 cubic yards of rock excavation. The explosive used was 60 percent polar forcite, and 3½ pounds were required per yard of rock.

BLASTING TAILRACE PLUG

A rock ridge, or plug, which served as a dam to keep the water out of most of the tailrace area during excavating, was removed by drilling blast holes, as shown here. The plug was 310 feet long and contained 18,000 cubic yards. Before the shot, the tailrace area was flooded with water to a depth of 15 feet to exert a cushioning effect against flying rock from the coyote holes. The water level on the riverside of the plug was 21½ feet higher than in the tailrace, and this had a tendency to throw the rock into the latter. To receive it, a 40-foot-wide section of the tailrace was excavated 10 feet below final grade level. After the blast, soundings revealed that less than 500 cubic yards of material would have to be removed to reach grade.



Sinking a Mine Shaft in South Africa

THE accompanying pictures show successive steps in the sinking of a deep shaft in the Witwatersrand gold-mining area of South Africa. They have not been published previously, having been prepared for the purpose of instructing shaft workers. For convenience in use, each photograph was mounted on a separate piece of cardboard, with the description printed alongside.

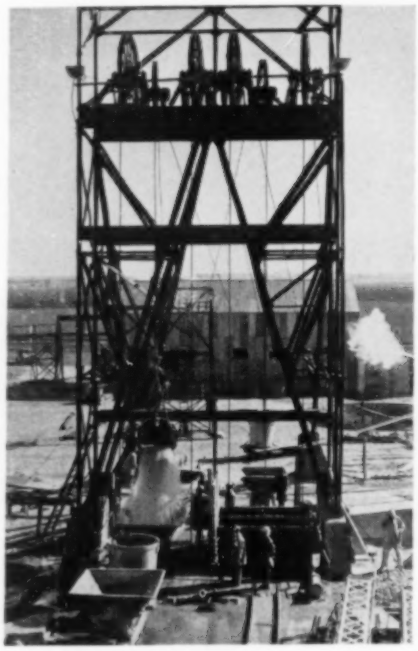
In spite of the large increase in other industries in South Africa, gold mining still ranks largest. Until diamonds were discovered there in 1870 and yellow metal was struck sixteen years later, the country was devoted mainly to agriculture. By the end of 1940, Rand mines had produced nearly 350,000,000 ounces of gold. Of the value of the 1944 mineral output, totaling $493,000,000, gold contributed 84 percent, or approximately $414,000,000. In that year gold made up one-third of the Union Government's revenue, and direct or indirect returns from the gold-mining industry supported about half the country's population.

In the eastern section of the Rand, where mining started, the gold-bearing conglomerates of the Witwatersrand formation outcrop at the surface. As the formation is traced westward in a wide arc the covering increases in depth, and in the West Rand it is as much as 3000 feet thick. For the most part, the mineralized reef, as it is known, dips at an angle of about 30°, although in some places it is comparatively flat. Workings following down the sloping bed have become steadily deeper, and in one mine they have reached a vertical depth of 8900 feet.

With increasing depth costs of extracting the ore have risen, and some of the older mines have become unprofitable and are no longer operated. Others are nearing the end of production and must inevitably shut down unless some of the physical, physiological, and economic problems associated with deep mining can be solved. In an effort to devise ways and means to make it possible to work profitably to a depth of 12,000 feet, the government and the Transvaal Chamber of Mines are sponsoring the Deep Level Mining Research Institute. Success in these efforts will greatly prolong the life of the gold-mining industry. After swinging westward, the reef turns southward, and drill-hole explorations have recently confirmed the long-held geological theory that its continuation would be found, deeply buried, in the Orange Free State. As a result, a large amount of virgin territory is available for mining if costs can be reduced sufficiently to yield profits.

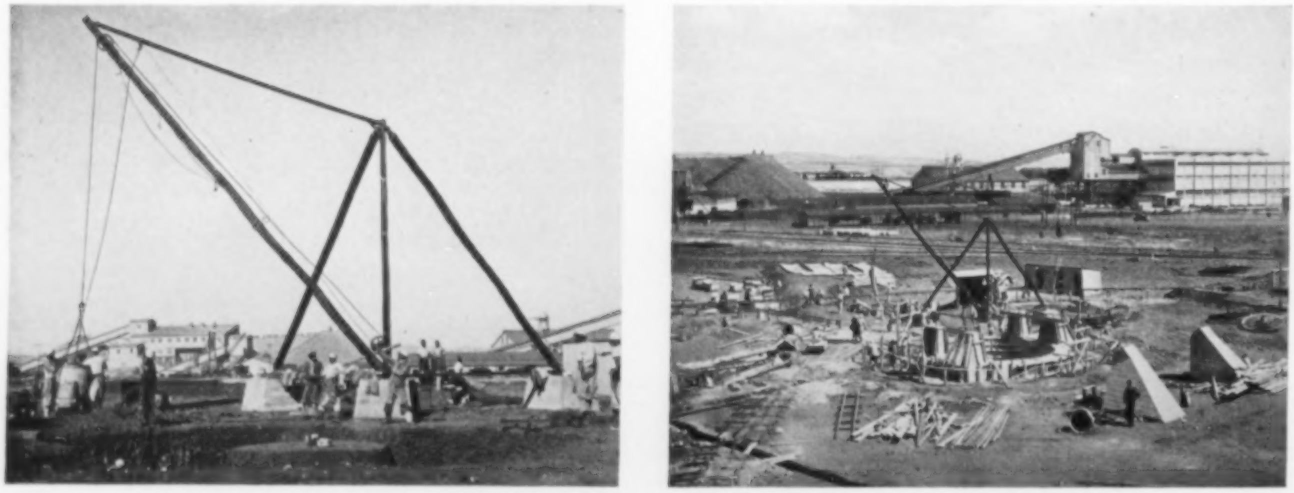
Despite the recession, South African gold mining is still flourishing. In 1941, the latest year for which complete statistics are available, the Union contributed 35 percent of the world's gold production. Canada ranked second with 13 percent, and was followed by the United States, with 11½ percent, and Russia, with 11 percent. Current output in South Africa is valued at around $1,100,000 a day.

In the first half of 1946, the 45 producing Rand mines milled 28,139,300 tons of ore, or an average of 156,000 tons a day. From it they recovered 5,903,210 ounces of gold, worth $198,195,000 at the prevailing price of 172 shillings, 6 pence per ounce (approximately $34.76). Ore output was 1¾ million tons less than in the first half of 1945. Most of this decrease was attributed to a strike last March and the remainder to the downward trend in gold mining that has been in evidence since the outbreak of war because of



SINKING HEADGEAR

In normal times, a headgear would have been designed especially for the sinking operations, but because of wartime conditions an old one was used. The four higher sheaves were for guide ropes from which a Galloway stage was suspended in the shaft to facilitate the work.



BREAKING GROUND FOR SHAFT

At the left is a job crane landing a 1-ton bucket of earth on a carriage for removal to a disposal area. The crane was operated by a 30-hp. electric winch. In the foreground is an island of ground that was left to hold a center pin until a circle could be established to delineate the shaft boundary. The right-hand picture shows the shaft collar nearing completion. Concrete foundations for the sinking headgear are at the right. In the background, from left to right, are the crusher station, waste-rock dump, slimes dam (white), extraction house, and mill.

CONCRETE PLANT

Concrete for lining the shaft was prepared in this batching plant. A 4-2-1 mixture, consisting of ½- and 1½-inch stone, sand, and cement, was used. These materials were hoisted by skip, the stone and sand to upper bins and the cement to a lower one. From these storage bins they passed through measuring bins to a 1-cubic-yard mixer having an operating capacity of 25 cubic yards an hour.

shortages of native labor, materials, machinery, and spare parts.

The value of the gold recovered per ton of ore milled averaged $7.07 in the first half of 1946. This represented a slight decline in grade from the previous corresponding period and was in line with the prevailing pattern in recent years. The largest individual operator was the Randfontein Estates, which crushed more than 2,000,000 tons of ore in the first six months of 1946. The ore was of considerably lower grade than the average for all the Rand mines, however, running only 0.127 ounce per ton valued at approximately $4.45. Six other mines each milled in excess of 1,000,000 tons. From the standpoint of gold recovery, Crown Mines was the biggest single producer, accounting for 332,534 ounces worth about $11,500,000. The Modder East was operated at the lowest working costs, equivalent to $3.60 for each ton of ore mined. Five other properties had working costs of less than $4 per ton.

South African gold mines rank high in the excellence of their technological practices, which are held in high esteem by mining men the world over. Mining has become a real science there, and close attention is paid to every detail in procedure. In the face of rising costs, even greater stress is now being placed on efficiency in management, organization, and methods. Geological conditions impose some problems that are not found in many other gold-mining districts.

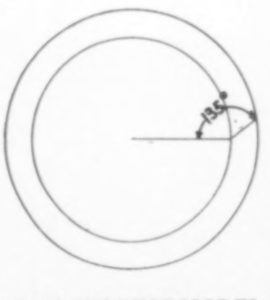
Outstanding among these difficulties is the narrow section of the mineralized zone or reef. It averages only about 3 feet in thickness, and some stopes provide a clearance of but 24 inches. This circumstance dictates the use of small, lightweight, hand-held rock drills of the Jackhamer type. Mining is done by natives, whose small stature is helpful in keeping openings small and, consequently, minimizes dilution of the ore with worthless wall rock that has to be handled at the same cost as ore. The story is told of a "boy" who was given a bonus for maintaining his stope at an unusually low height. But he unfortunately spent too much of his extra stipend for food and was cut off the payroll because he could no longer squeeze into the working chamber.

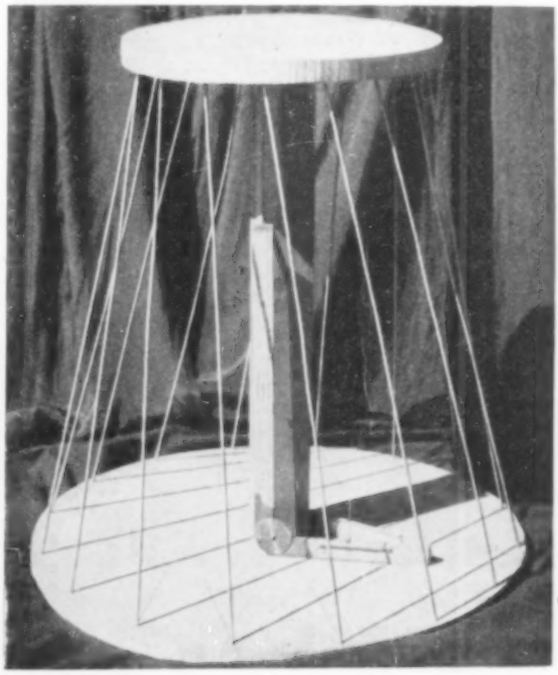
As is true of all phases of mining procedure, shaft sinking has been developed to a high degree of efficiency. Owing to the nature of the sediments overlying the reef, it is necessary in many localities to consolidate the ground by grouting or cementation in advance of sinking. That was done in the case of the job that is illustrated here. As a result of good organization, effective methods, and thorough training of the working forces, fast progress is made in shaft excavating. The record for 30 days is 429 feet, but the character of the ground penetrated in that case was such that cementation was not required.

Most shafts used for hoisting are of rectangular cross section. The one under consideration is intended solely for ventilation and is of circular section because this design is of advantage in that it offers a minimum of resistance to the air flow and entails the least amount of excavating for handling a given volume of air. In addition, the walls are more resistant to lateral pressure from the surrounding rock than those of square section.

The shaft was sunk through dolomite that is heavily water-laden. It is 22 feet in diameter inside a monolithic concrete lining. The thickness of the latter, and therefore the excavated size, depended upon the condition of the rock, which varied at different horizons. The lining ranged from 7 inches thick in good ground to 24 inches in soft ground. Operations were carried out under the technical direction of New Consolidated Goldfields, Limited, and the Cementation Company (Africa) Limited. The pictures are reproduced by permission of Carlton Jones of the first-mentioned concern. The descriptions for them, which have in some cases been modified or amplified to suit our purpose, were prepared by W. Allen, manager of the Sub Nigel Mine.

Progressive deepening of the shaft involved repeating, in sequence, the three operations of cementation, sinking, and walling. Cementation covers the exploration of the ground, ahead of sinking, by means of drill holes and the injection of grout wherever conditions call for it. In this instance, the cementation holes were drilled to a depth of 32½ feet, the headgear being of insufficient height to permit using longer steel. Through these holes could be grouted a vertical section of ground that made it possible to sink the shaft from 22 to 24 feet and still leave a protected section about 6 feet thick at the bottom. It was pointed out, however, that it would be preferable to drill 40-foot holes because the added footage would expedite sinking by reducing the number of treatments that would have to be given the ground per 100 feet of depth.

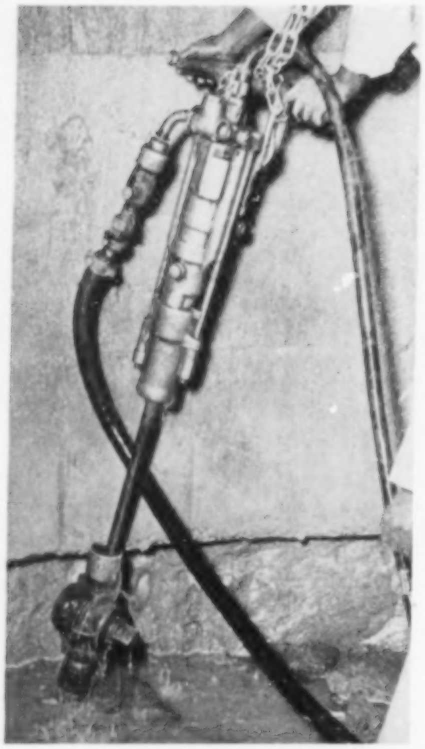




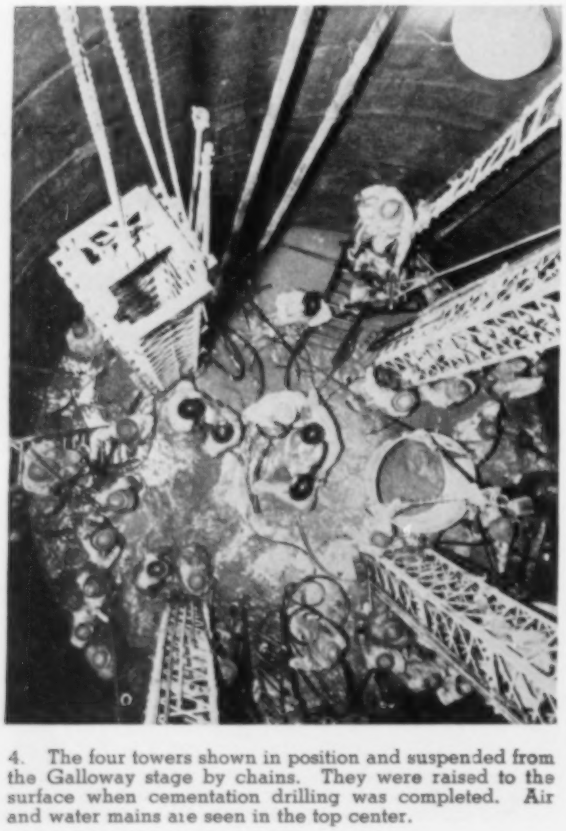
HOLE-SPACING MODEL

Top disk on the model represents the shaft bottom and the wires the deep cementation holes that were drilled in advance of excavating. The 16 holes were drilled with a spin of 135° from a radius, as shown above. They terminated in a circle having a diameter of 33 feet, or 11 feet greater than the shaft bottom. This provided a final cover of 5½ feet all around the shaft bottom.

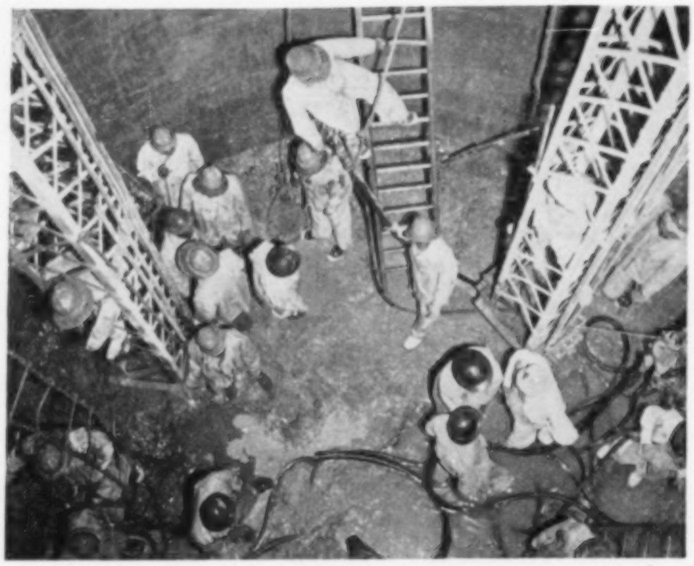
CEMENTATION



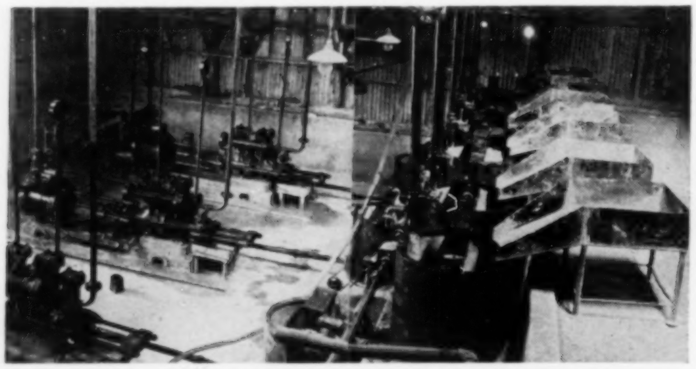
1. Because they might strike water under pressure, cementation holes (32½ feet deep) were drilled through a valve screwed onto a 2½-inch casing grouted 4 feet into rock. Holes for the casings were drilled with 4-inch drills mounted on tripods. Cementation holes were then put in with 3-inch drills, like the one shown, using 1¼-inch hollow drill rods and Jackbits. Successive drill rods differed in length by 7½ feet.



4. The four towers shown in position and suspended from the Galloway stage by chains. They were raised to the surface when cementation drilling was completed. Air and water mains are seen in the top center.



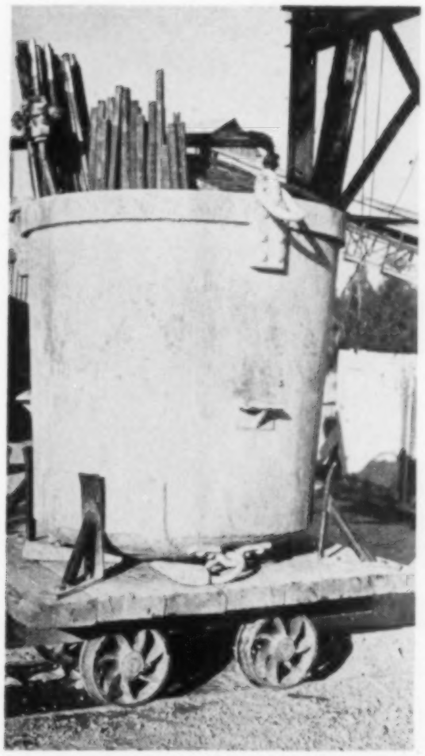
2. A view of the shaft bottom during cementation drilling. Drill rods were lowered by attaching them to the latticed towers, of which there were four, one for each drill. Two towers can be seen. The native on the ladder is holding a drill. It was raised by means of a rope passed over a pulley and fastened to the Galloway stage overhead



3. Cementation drilling took, roughly, 15 hours. When water or soft ground was encountered, cement grout was pumped into the holes from the surface plant shown above. Three 1½-inch pipes were run down the shaft and connected to the valves on the casing pipes. The time required for cementation varied with the amount that had to be injected.

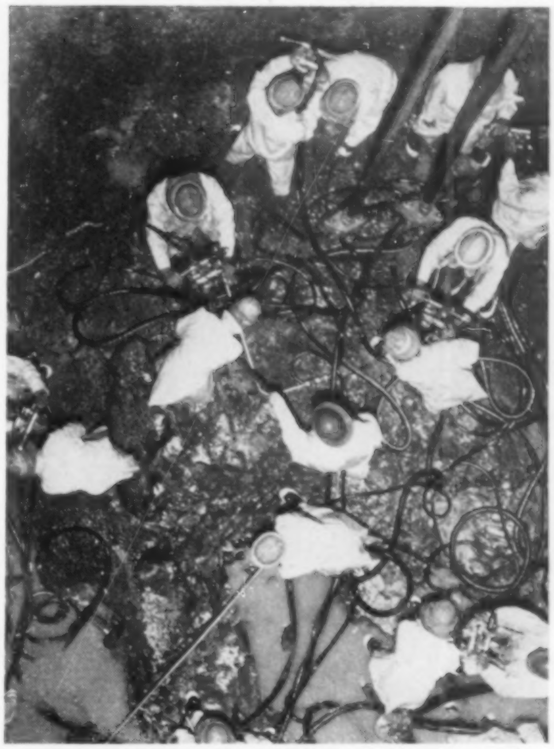
5. To clear the shaft bottom of water, air-operated pumps discharged into a bucket, which was hoisted for dumping. A tower with drill rods on it is in the background.

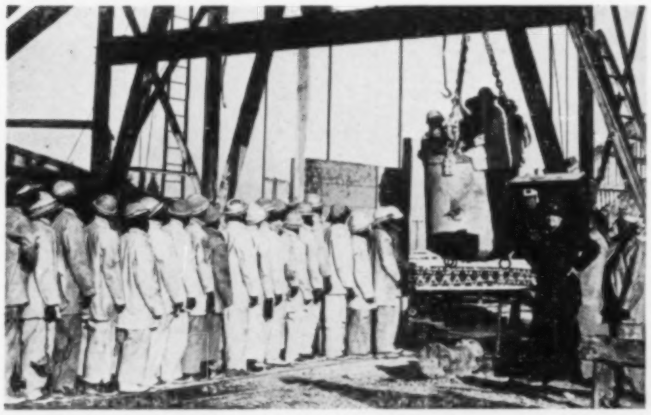
SINKING



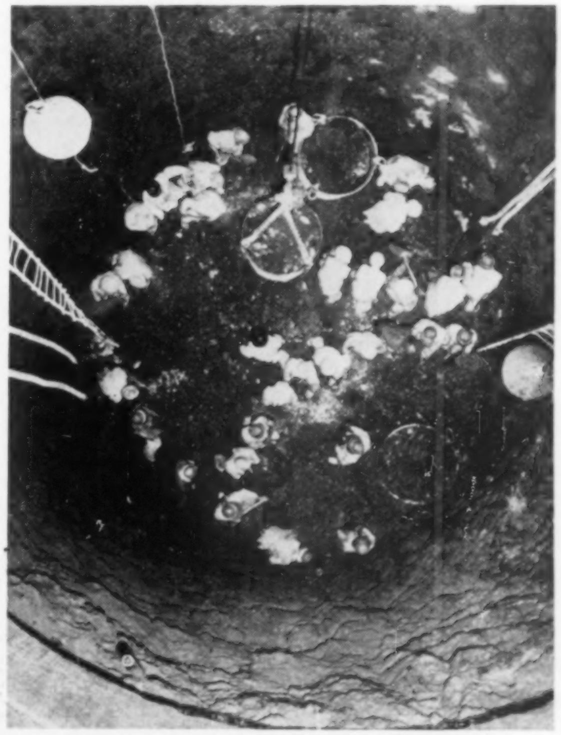
6. Left- Drilling equipment ready to be sent down for sinking. The equipment consisted of ten 3-inch drills, 76 sets of steels in four lengths ranging from 2½ to 6¼ feet, ten 25-foot lengths of ½-inch hose, four 6-way manifolds that were hung on 2-inch hoses from the shaft mains, a blowpipe for cleaning holes, and a metal measuring staff for locating holes with reference to a central pin.

7. Right- Blast-hole drilling. A round of 76 holes was drilled 5 feet deep in concentric circles around a sump cut and usually broke 4½ feet. Holes were loaded with 50 percent Gelignite connected in parallel and fired electrically from the surface. After all wires had been joined and the crew was out of the shaft, the master sinker made the final connection with the blasting cable and was then raised to the surface to fire the shot.

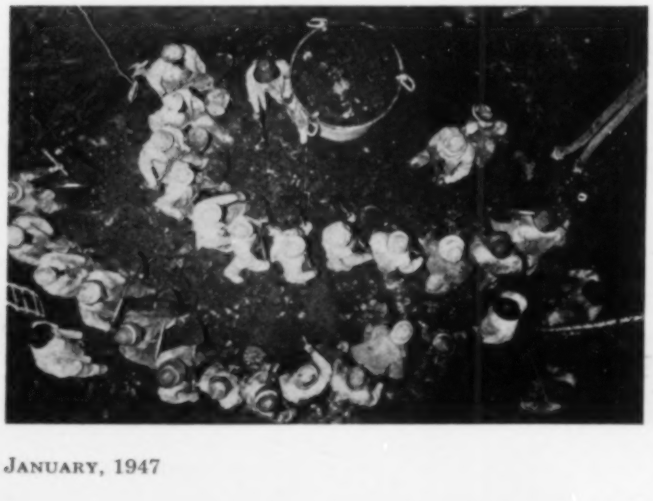




8. The loading shift was lowered twenty minutes after blasting. Approximately 40 natives constituted a sinking shift: ten machine runners, ten spanners, twenty shovelers. Machine boys also acted as bar, hook-on, bell, and boss boys; spanner boys also did shoveling. The time required to make a 4½-foot advance was eight hours, divided as follows: drilling, 1½ hours; charging and blasting, ¾ hour; shoveling, 4½ hours; blowing over and examining misfires, ¾ hour; rest and traveling, ½ hour.

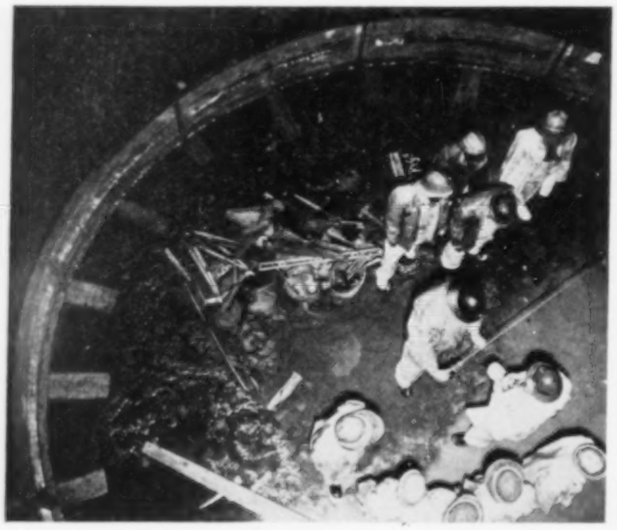


10. Another loading scene, showing the entire bottom. A hoisting rope has been attached to one bucket that is leaving for the surface. Two other buckets are almost full. Floodlights may be seen at the right and left, as well as a ladder extending down from the Galloway stage at the left. The lower part of the concrete-lining wall is visible at the bottom of the picture.

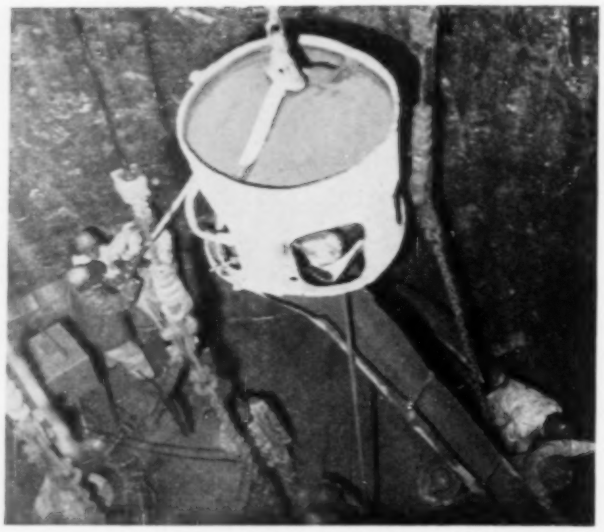


9. Left- Loading broken rock into a 2-ton bucket. Note the arched rows of natives. Those farthest from the bucket threw over those in the nearer line as they bent over in unison to fill their shovels. If a boy in the rear row struck one in the front row, he had to change places with him. From 20 to 24 buckets were loaded and hoisted per hour. At the top left a bell wire is visible.

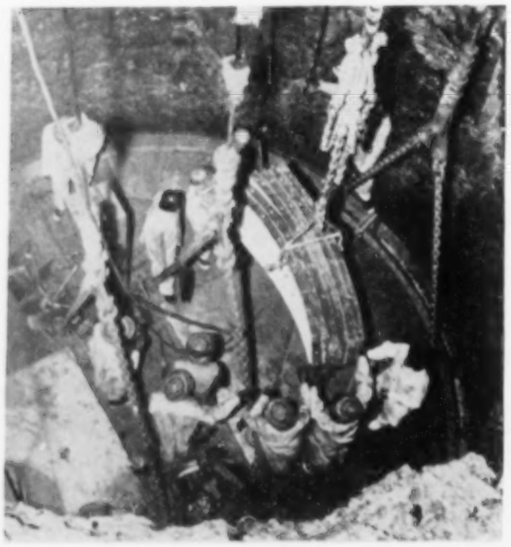
WALLING



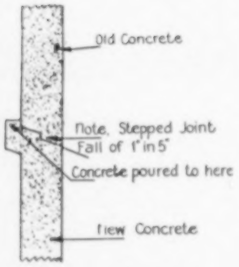
11. The concrete lining was poured from the bottom upward behind "tubbing," circular rings composed of eleven plates 6.34 feet long and 2½ feet high. In this view the bottom ring has been set on timber blocks and leveled and is being checked and adjusted to form a true circle by measuring from the center with a plumb bob.



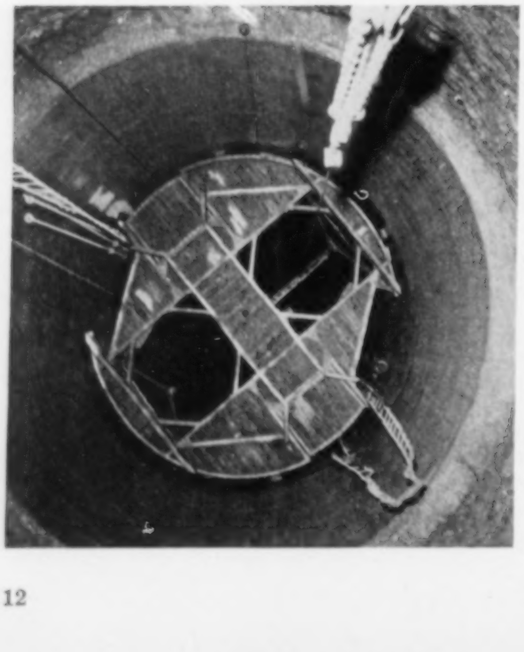
12. Pouring concrete from a 1-cubic-yard bottom-discharge bucket with a chute attached. The chute could be moved around so as to place concrete wherever desired. It traveled up and down with the bucket. The natives on the left are pulling the arm to open the bucket discharge gate.



13. Left- Two rings (5 feet high) were filled with concrete and then two more rings were added. The plates were lowered as shown here, bolted to the ring below, and checked. The inside surface was rubbed with oil before each pouring to prevent concrete from adhering and thus facilitate removal of the plates. The actual work of lining was done at the rate of 3 feet an hour. The over-all progress from the time of the preceding blast to the beginning of the next operation, which would be either cementation or sinking, was 1½ feet an hour.



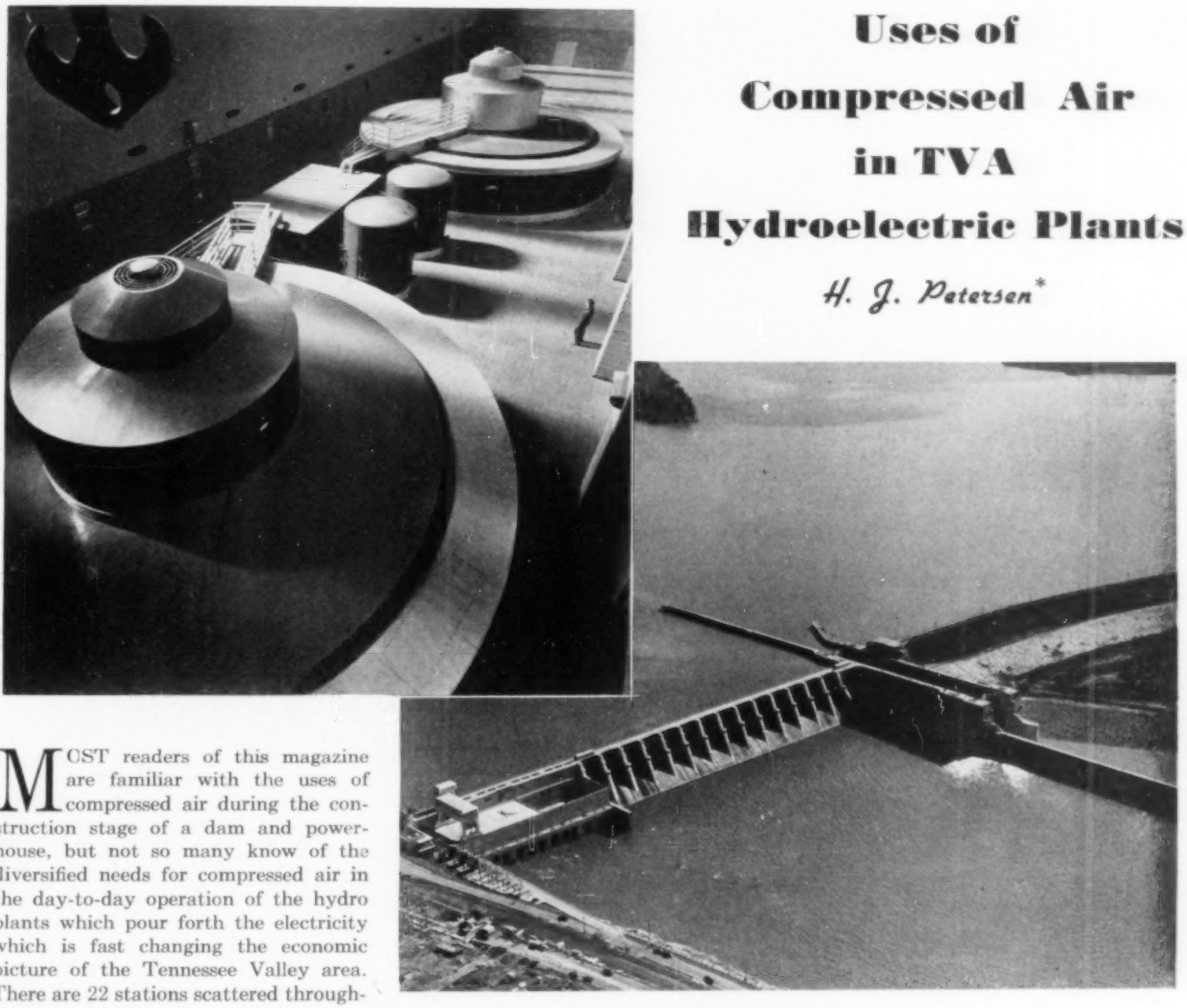
14. Removing the top set of plates after concrete had set. The plates were of special construction, being stepped in 6 inches at the top to permit pouring the final concrete from above the joint with the lining that had previously been placed. A section through a joint is shown at the right. The projecting concrete was chipped off after the plates had been removed. The workmen are standing on the Galloway stage.



15. Left- A view looking up the shaft at the underside of the Galloway stage. Openings for passage of the buckets are visible, and in the one on the right may be seen the crosshead. Note the bottom edge of the concrete lining. The ventilation pipe, hidden by the stage, was 22½ inches in diameter. At the top are bucket chains hanging from a rope.

Uses of Compressed Air in TVA Hydroelectric Plants

H. J. Petersen*



TWO TVA UNITS

At Pickwick Landing Dam, compressed air brakes six 40,000-kva. generators, two of which are illustrated at the top. Between them may be seen their two pressure tanks that contain governor oil stored under 300 pounds air pressure. The other view shows Fort Loudoun Dam, with the powerhouse on the left and the navigation lock on the right. The lock chamber measures 60x360 feet, and the maximum lift is 80 feet, the highest of any single-lift lock. TVA dam locks are operated by the Army Engineers and have their own compressed-air systems.

MOST readers of this magazine are familiar with the uses of compressed air during the construction stage of a dam and powerhouse, but not so many know of the diversified needs for compressed air in the day-to-day operation of the hydro plants which pour forth the electricity which is fast changing the economic picture of the Tennessee Valley area. There are 22 stations scattered throughout this region, and because they differ in type, size, and geographical location the compressed-air demands at each vary somewhat.

Compressed air is used in and around a waterpower plant for braking the main generators; providing pressure for the governor hydraulic system; depressing tail water below the runners for synchronous-condenser operation of the units in stations where tail-water level is normally above the runners; for the prevention of ice formation on the spillway gates; controlling pneumatic regulating valves; operating pneumatic tools and air motors; blowing out clogged water intakes and drains; and for grease pumps which lubricate turbine wicket-gate bearings.

Since the maximum pressure for all these purposes, except the governor pressure, is 100 pounds per square inch, that pressure has been adopted as standard for the general powerhouse system, with regulating stations supplying air at lower pressures for individual needs. A stationary, horizontal, cross-head-type, double-acting, water-cooled, 325-rpm., V-belt-driven, single-stage machine, varying in capacity from 100 to 440 cfm. at the different plants, is used by the Authority for this service. This unit is supplemented at each station by a motor-driven, air-cooled, 2-stage portable machine that serves outlying areas not connected to the general piping system. Dual control is provided for all stationary compressors. Water-cooled aftercoolers are used after all single-stage units and air receivers are installed, as required.

Air at 100 pounds pressure is usually supplied to the generator brakes, but in a few instances the generator manufacturer has requested that this pressure be reduced to 80 pounds. The brake control valve for each unit is manually operated and is mounted on the governor cabinet. The braking system consists of a number of brake shoes that are located under the outer rim of the generator rotor and that close when air is admitted to the cylinders in which they are housed.

Compressed air for operating ventilating-damper motors and controls and for loading pressure on diaphragms of pneumatically actuated regulating valves is reduced to 15 or 20 pounds, while air at 100 pounds is used for the pumps that deliver grease to various bearings lubricated under pressures of 3000 to 4000 pounds per square inch. Some of the inlets for raw water are permanently underwater, and these are provided

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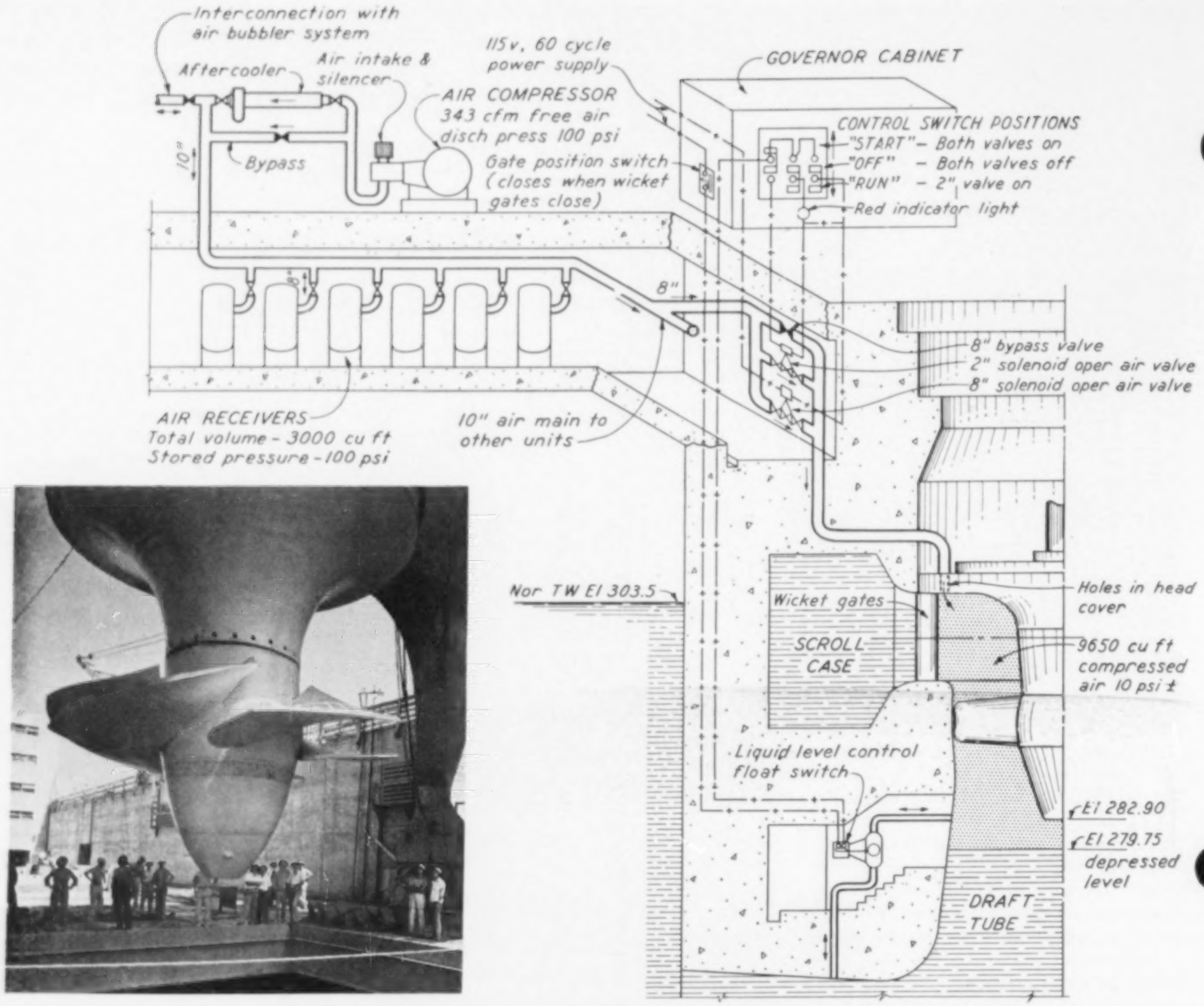
*Head Mechanical Engineer, TVA.


Interconnection with air bubbler system
Aftercooler
Air intake & silencer
115v, 60 cycle power supply
GOVERNOR CABINET
AIR COMPRESSOR 343 cfm free air disch press 100 psi
10"
Bypass
Gate position switch (closes when wicket gates close)
CONTROL SWITCH POSITIONS
"START" – Both valves on
"OFF" – Both valves off
"RUN" – 2" valve on
Red indicator light
8"
8" bypass valve
2" solenoid oper air valve
8" solenoid oper air valve
AIR RECEIVERS
Total volume - 3000 cu ft
Stored pressure - 100 psi
10" air main to other units
Nor TW El 303.5
Wicket gates
SCROLL CASE
Holes in head cover
9650 cu ft compressed air 10 psi ±
Liquid level control float switch
El 282.90
El 279.75 depressed level
DRAFT TUBE

DRAFT-TUBE-EVACUATION AIR SYSTEM

The schematic control diagram is explained in the text. One of the 44,000-hp. Fort Loudoun Dam turbines with which this system is used is shown at the left. Ordinarily the turbine drives a 40,000-kva. generator, but when it is desired to operate the generator as a synchronous condenser, compressed air is applied to depress the water in the draft tube below the revolving blades. The latter are sometimes submerged as much as 17 feet.

with 1-inch valves to which air hoses may be attached for blowing out or clearing debris from the inlet gratings.

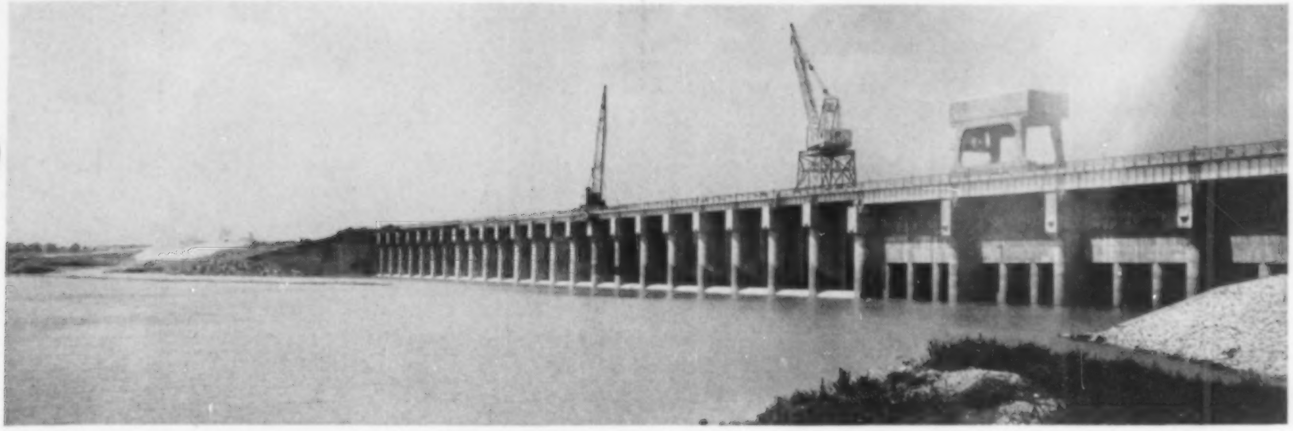
To eliminate cavitation in the propeller-type turbine blades as much as possible, these runners are submerged, sometimes as much as 17 feet, below normal tail-water level. System voltage regulation and power-factor correction require that a certain number of generators be operated as synchronous condensers, that is, at full speed and no load. Under these conditions, a unit revolving in water would consume about 4000 kw., as against approximately 700 kw. while revolving in air. To save this power, the water in the draft tube is automatically depressed below the runner by compressed air. This is accomplished as follows: (Refer to schematic control diagram.)

With a unit on load, the control-room operator signals the governor attendant when he wishes to run a generator as a synchronous condenser. The latter then sets the control switch on the "Start" position, thus energizing the solenoids of both the 8- and 2-inch air valves. The switchboard operator next backs off his load, and when the wicket gates are closed, the electrical circuit is completed through a contact on the gate-position switch, which allows both the 8- and 2-inch solenoid valves to open fully and admit compressed air into the draft tube.

When sufficient air has been released into the draft tube to depress the water level below the turbine blades, the float switch on the tube shuts off the air valves. The governor attendant then sets the control switch on the "Run" position, which permits only the 2-inch valve to function under regulation of the float control to compensate for any leakage loss from the draft tube and to maintain the despressed water level. The red signal on the governor cabinet lights each time the air valves open to indicate to the attendant that air is being admitted to the draft tube.

To restore the unit to operation as a generator, it is only necessary to open the wicket gates and to set the control switch on the "Off" position. With the air supply shut off, the air will be forced out of the draft tube to the tailrace as the gates open and the headwater enters. With tail water at normal elevation, the air pressure required to depress the water below the runner is approximately 10 pounds, the volume varying at each plant. It takes about one minute to put "a unit in the hole," as the operators call it. Evacuation facilities have been installed in five powerhouses to date, and provisions have been made for such systems at two others.

The Kentucky hydroelectric station is located near the mouth of the Tennes-



UPSTREAM FACE OF KENTUCKY DAM

The spillway section in the center of the structure is protected from ice formation by pumping compressed air into the water in front of each opening. This agitates it and brings the relatively warmer subsurface water to the top. Intakes to the power units are at the right.

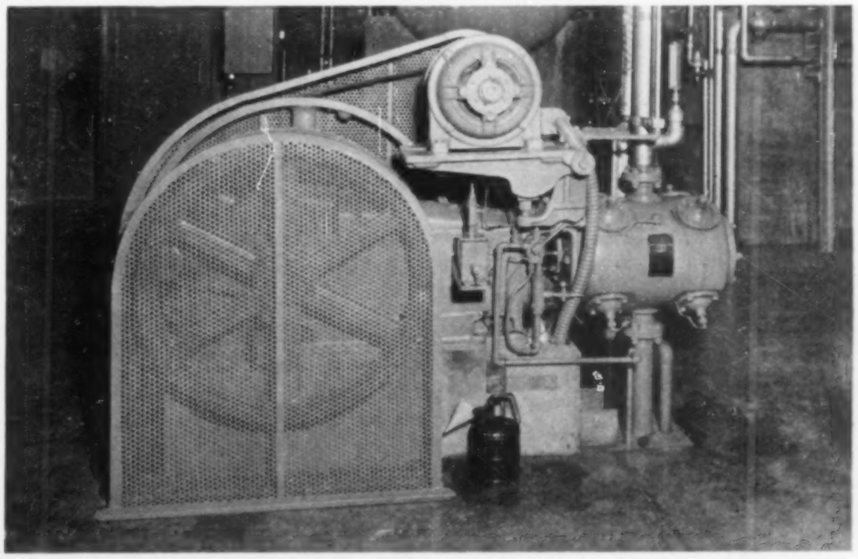
see River where it joins the Ohio. Observations made during the construction period indicated the possible formation of ice on the spillway gates. This would, of course, endanger their operability and might destroy their function as flood-control safety factors. Consequently, it was decided to use compressed air to keep these gates free from ice. The system is supplied by one stationary, single-stage, double-acting, motor-driven machine having a capacity of 340 cfm. operating at a pressure of 100 pounds. This unit is a duplicate of the draft-tube-evacuation air compressor, and the two systems in this plant are interconnected to provide stand-by capacity for each other.

A complete piping system carries the air from a receiver through a pressure-reducing station to 24 valved outlets located in boxes on the spillway deck. There is one box for each 40-foot spillway bay, and it contains a throttling needle valve, a strainer, a pressure gauge, and two ½-inch hose connections. When freezing weather occurs, either one or two lengths of ½-inch armored hose are attached to the connections in the box at each gate bay to be kept ice free. The other end of the hose, which is fitted with an orifice nozzle, is submerged in about 10 feet of water on the reservoir side of the gate.

Experiments conducted in connection with a similar system at Grand Coulee Dam proved that reservoir-water temperatures at depths of more than 8 feet remain relatively constant and that surface ice produces very little change in temperature. Compressed air discharging underwater induces an upward flow of the warm water, and this prevents the formation of surface ice. Tests were also made with compressed air discharging through orifices, and these indicated that a sharp-edged orifice of ⅛-inch diameter and a tube length of three diameters give the best bubble pattern to induce the required upward mixing flow. The main-line pressure for this purpose is carried at 25 pounds, and the air supplied to the orifice is throttled to around 6 pounds by the needle valve.

Oil for the servomotor cylinders in the governor system is stored in receivers on the generator floor. These receivers are about two-thirds full of oil, with the top one-third containing air under pressure. The governor oil pumps start and stop automatically to maintain a minimum of 250 pounds pressure in the system, and air is forced into the top of the receivers at intervals to maintain the air cushion. Compressed air for this service is separate from that for any other because of the high pressure required, and the compressors that deliver it are furnished by the governor manufacturer as part of the equipment. They are generally 2-stage, air-cooled, V-belt-driven units mounted on a small receiver and range in capacity from 8 to 15 cfm. at 300 pounds pressure.

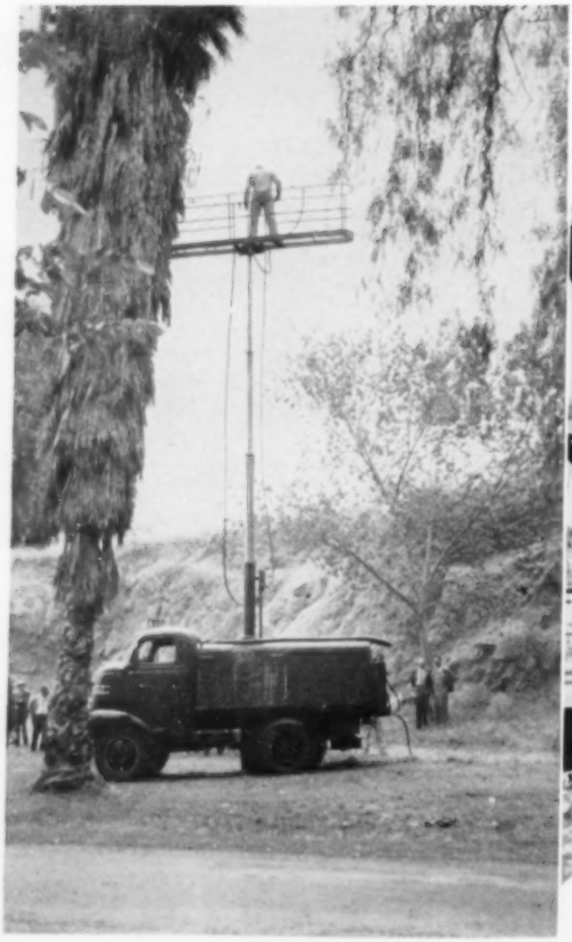
All the nine dams on the Tennessee River, from the Kentucky [illegible]r its mouth to the Fort Loudoun just below Knoxville more than 600 river miles upstream, have locks as a feature of the navigation program whereby a 9-foot channel is maintained throughout this stretch of the waterway. Each lock is supplied with compressed air for tool service and for a navigation signal horn, and because it is always located on the far side of the dam and remote from the powerhouse compressor installation, and because all machinery and equipment in the locks are operated by the U. S. Engineer Department, a separate air system is provided for that purpose. This usually takes the form of a 2-stage, air-cooled, motor-driven compressor rated at 60 cfm. and 100 pounds pressure.

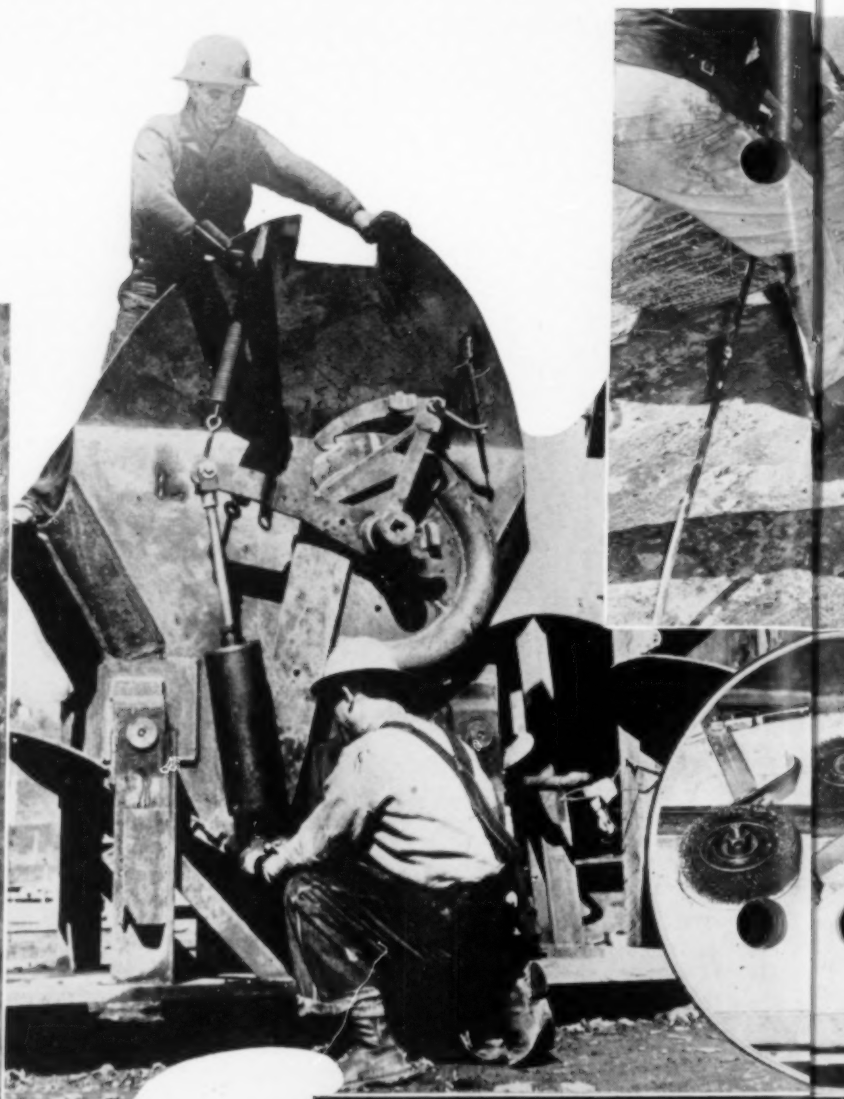


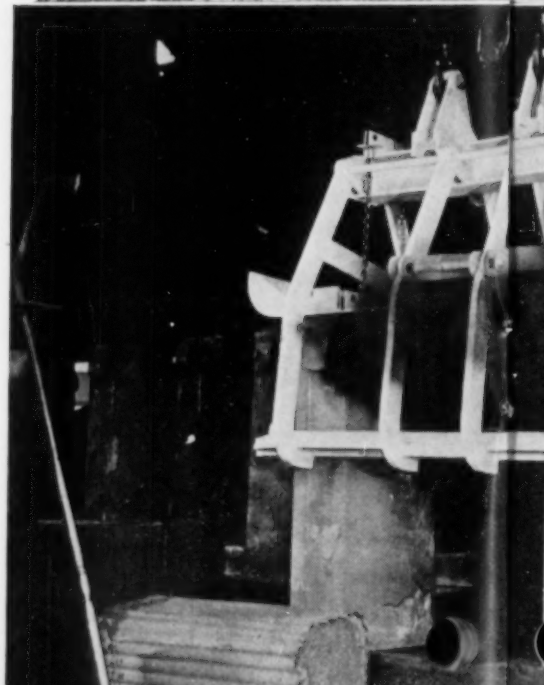
POWERHOUSE COMPRESSOR

This 8x9-inch, single-stage Ingersoll-Rand unit supplies air at 100 pounds pressure for operating generator brakes, pneumatic tools, and control valves in the Chickamauga powerhouse. It is equipped with dual control.

Compressed Air at Work







The equipment shown above was demonstrated at a summer meeting of the Western Chapter of the National Shade Tree Conference at Riverside, Calif. A hydraulic lift raised the platform 30 feet above the truck on which it is mounted, and a workman at this elevated station then used an air-operated saw to trim the eucalyptus tree at the left. The same outfit enabled sprayers to reach the tops of tall trees.

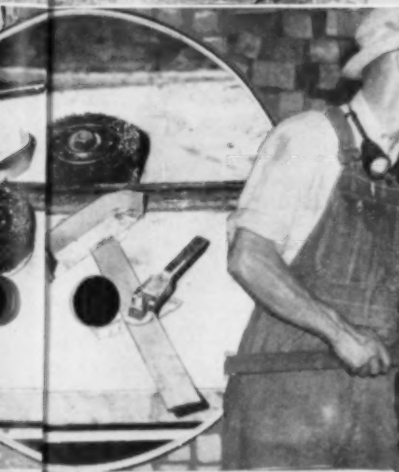
●

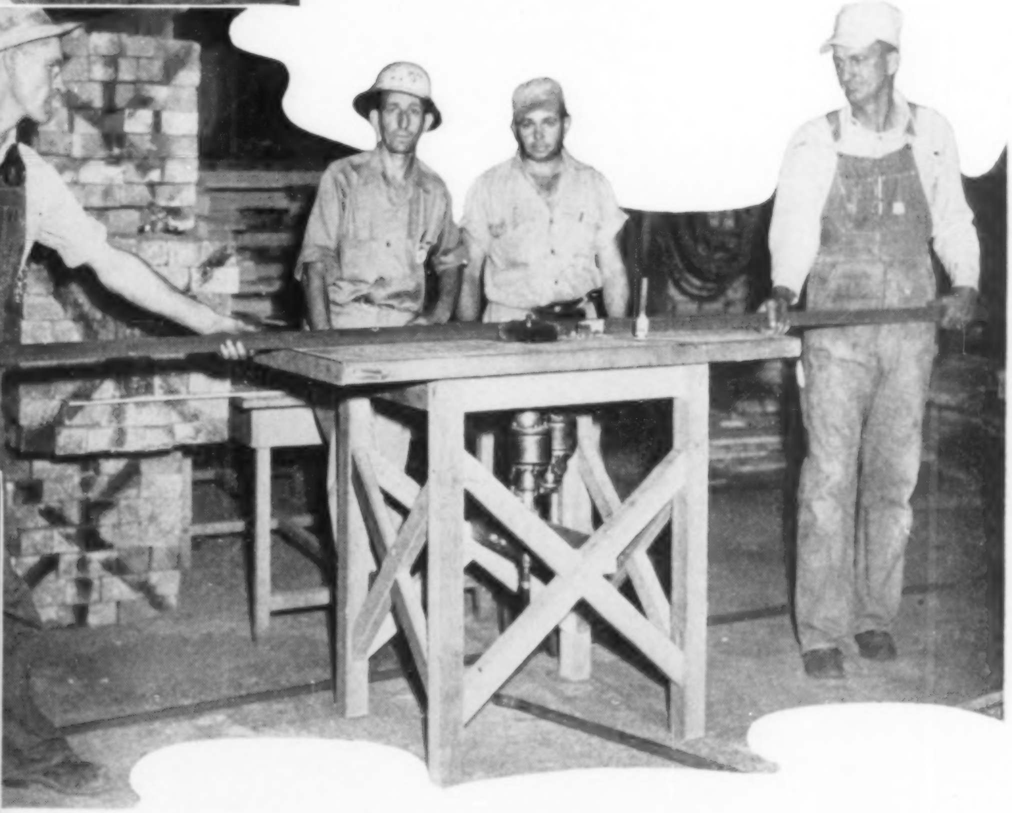
Pictured at the top-right is the operating mechanism of an air-dump concrete bucket designed by Tennessee Valley Authority engineers for use in building Fontana Dam. The bottom gate was opened by the cylinder and piston and closed by the semicircular counterweight. When in service, a cylindrical shell enclosed the bucket to protect the working parts shown here. Conventional buckets require on an average fifteen seconds to open them with a hand wheel; this type was dumped in two seconds by inserting the nozzle of a compressed-air line into a socket near the base. As 700,000 buckets of concrete were deposited in the dam, the time saved by this device aggregated three weeks. This was important because the dam was being hurried to completion to supply vitally needed hydroelectric power for war work.

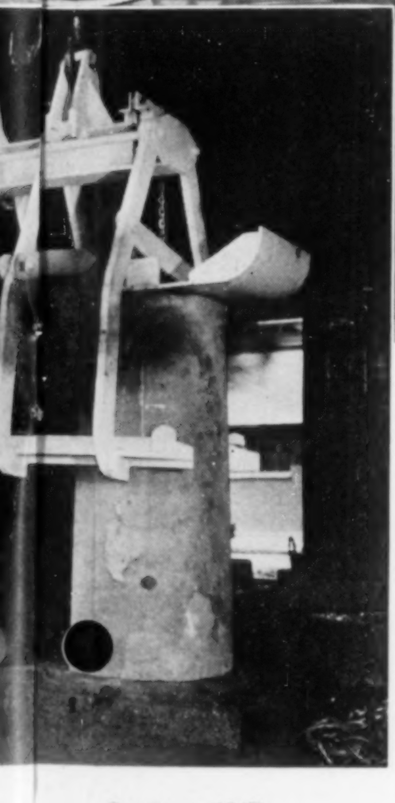
The way you view a thing sometimes makes a big difference in what you see. The picture at the left is innocent enough as it appears here. It shows an air spray applying an asphaltic lining to the side of an irrigation canal during tests conducted by the Boise, Idaho, office of the U. S. Bureau of Reclamation. But turn the picture so that the left edge becomes the bottom and you see murder being done. The sinister shadow effect was obtained purely be accident.

●

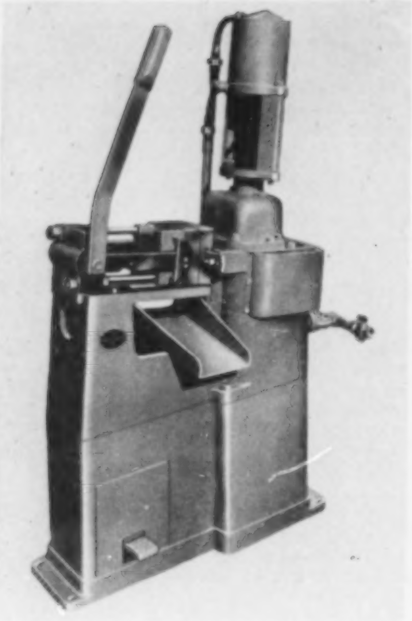
Two standard air-powered grinders equipped with wire brushes are mounted on the table below to expedite the removal of rust from iron strips at the Ingalls Shipbuilding Corporation, Pascagoula, Miss. The inset (circle) shows the brushes, with adjustable guides for controlling the travel of the strips being treated. The machine, which was suggested by an employee, is used to derust furring channels, angle iron, and similar shapes. With it, two men can clean 11,000 lineal feet in eight hours, as compared with 2500 feet when holding power-operated brushes in their hands. It is also safer, as all the rust is whisked away from the workers.

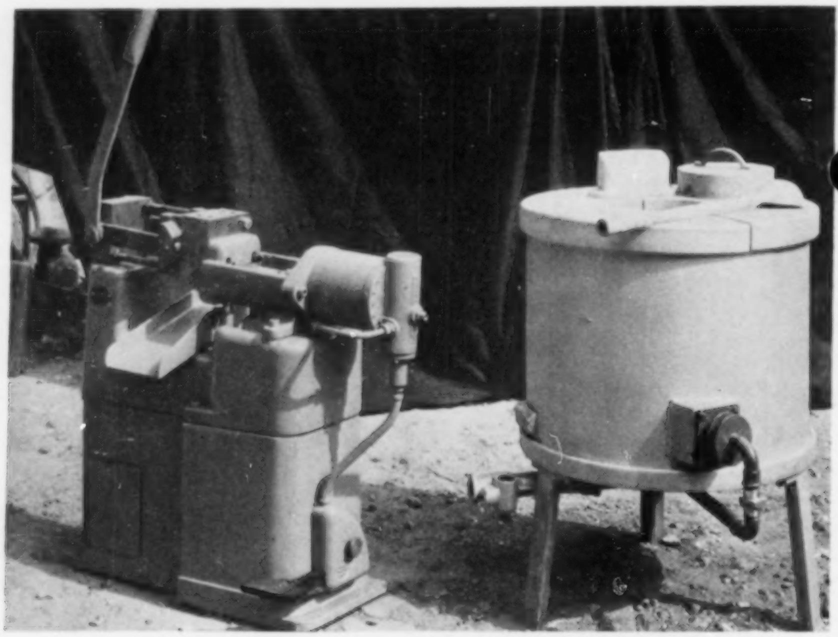


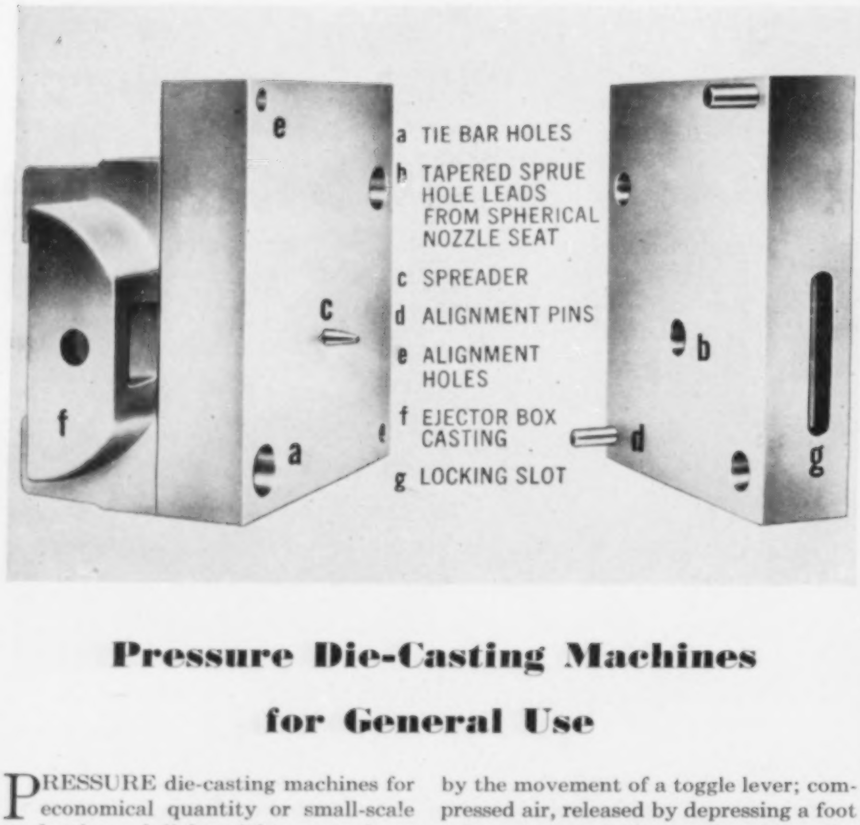




By means of the set-up shown at the left, molds in which steel ingots are to be poured at the National Tube Company, McKeesport, Pa., are "greased" inside with powdered coal-tar pitch to prevent the metal from sticking after it has cooled. Three molds are handled at a time by means of a special crane-operated lifting rig. After being dipped in water to remove any contained dirt, the molds are lowered on to a spraying platform where they rest open end down. Compressed air at 90 pounds pressure then blows in the powdered pitch through three conical depressions centered under the molds. Only five seconds is required to coat each one adequately. The pitch is contained in a hopper beneath the platform and is agitated with air to prevent it from packing and also to insure constant delivery to the 2-inch suction lines extending to the spraying points. This new mold-preparation system has reduced scrapping and scarfing of billets made from the ingots, and the coating is considered better than that previously obtained by the use of tar, fuel-oil, graphite, or brine.







AIR-OPERATED UNITS

Machine at top-left produces zinc- or lead-alloy castings. The pot unit is at the right and has a built-in gooseneck with a special nozzle against which the die unit is securely clamped. The pot is gas-fired and is designed so that the nozzle does not have to be heated separately. It has a capacity of 70 pounds. In the case of the model for aluminum castings, above, the metal is poured by ladle into an injection cylinder from which it is forced into the die cavity by a foot-controlled pneumatic plunger. The bail-out furnace, right, used in connection with this machine holds a charge of 40 pounds. It is tangentially fired by two air-blast burners fitted with air-gas proportioning apparatus. Die sets can be changed in two or three minutes and are supplied in the form shown at the left.

Pressure Die-Casting Machines for General Use

PRESSURE die-casting machines for economical quantity or small-scale production of lightweight parts have been designed to make manufacturers independent of outside sources of supply. The units, which were developed in England and put to use there during the war, are designed for both hand and compressed-air operation. Our interest centers in the pneumatic machines, of which there are two models—the M55A for zinc, tin, or lead-base alloys and the ADC56 for aluminum.

The first-named machine is made up of a pot unit and a die unit. Its casting cycle is as follows: The dies are locked by the movement of a toggle lever; compressed air, released by depressing a foot valve, operates a plunger that forces the metal into the die cavity; lifting foot from pedal returns plunger to "up" position, uncovering the gooseneck which is an integral part of the melting pot and recharging it for the next shot; reversing the movement of the toggle lever ejects the casting. An important feature of this unit is a safety device that shuts off the air supply for the piston downstroke until the dies are securely locked, thus preventing the chance of pumping metal while the dies are open. Parts with a maximum area of 9 square inches and weighing up to 5 ounces are cast by this model.

The machine for the production of aluminum castings differs in construction but works on much the same principle as the M55A. It turns out parts up to 2½ ounces in weight and 9 square inches in area. Both models are operated with air at 80 pounds line pressure and consume 3.5 cfm. per cycle. Prefabricated die sets are supplied for use with the machines. They are complete except for sinking gates and cavities, which latter may be cut directly into the die plates or into steel pads which can be fitted into the plates. The average cost of this item is said to be comparable to that of a good blanking die. It is further claimed that the machines' high operating speeds make it possible to utilize single- instead of multiple-impression dies and that as many as 1500 castings an hour have been produced on the M55A with an average of 5000 shots a day. For the laboratory or shop, where the runs of die-cast parts are generally low, as few as 1000 shots are in cases economically practicable.

Panama Canal Must be Modernized

R. J. Kirkpatrick[*]

LAST year, on August 15, the Panama Canal started its thirty-third year of operation. On October 19, 1938, the 5000-ton steamship *Steel Exporter* was the hundred-thousandth commercial vessel of more than 300 tons net to transit that waterway. Not long afterward the total tolls collected exceeded the construction cost. But shortly after that happy financial state war seemed imminent, and the Canal Zone and its vicinity went almost completely military. Between 1939 and a fairly recent date the zone was a vital place in the Army, Navy, and Air Corps' prosecution of the war, and thus for the second time in its history served largely as a military base. It can therefore be said that the canal's record has honored its pioneers. Now, though seriously retarded through various causes, shipping is falling back into its old-time trade lanes.

In the meanwhile, however, many features of the waterway have been outgrown and become outmoded. In October, 1946, the world's largest floating crane was "scraped" through the locks by a combined Navy and canal force. This strong-backed structure can lift 350 tons, and was doing just that sort of thing not so long ago for Nazi Germany. Now it will do it for the Navy in Pacific Coast yards. Lately, one like it hoisted submarines in the ill-famed submarine pens at Bremerhaven, Kiel, and Hamburg. By removing the wooden, rubbing side rails from the 109-foot 10-inch-beam floating crane, 1 foot 1 inch was added to the theoretical 2-inch clearance available for its passage through the 110-foot-wide lock chambers.

Again, during the latter part of the war, the Navy seriously needed in the Pacific two giant floating steel dry docks that were on the Atlantic seaboard. These structures offered a seemingly impossible transit job because of their 124-foot beam. However, the transfer was done by careening the docks onto their sides (which then became ten stories high) and towing them through laterally—a tricky, dangerous piece of navigation in a tropical trade wind. (Described in our December, 1945, issue.)

But there is a limit to what even the resourcefulness of the Navy and Panama Canal forces can do! For instance, nobody can get the too-wide and too-long transatlantic liners *Queen Elizabeth* and *Queen Mary* through the locks, and they served as Army transports during the war. Neither can certain of our wartime-built craft use that short cut. So the $277,000,000 project Congress authorized for enlarging and modernizing the Panama Canal—including, among other things, a third set of locks some distance from the present ones—was justified, but it came a little late. Work in the field was inaugurated on July 1, 1940, but the succeeding war-made shortages of skilled construction men, equipment, and materials caused a stoppage of all contracts when the excavations for the new locks were virtually completed in 1942. As it turned out, this cessation was providential. Although about $70,000,000 had been expended, much of what was done was essential to the canal's defense.

Now the whole matter can be and is being restudied, with reference to the war's experiences and developments, particularly to the atomic bomb's possibilities as revealed by its use in New Mexico and Japan and by the Bikini tests. Undoubtedly, the plans will be changed considerably to meet existing, radically altered conditions. The board has several schemes under consideration. It may recommend the construction of a sea-level route with Pacific tidal locks; relocation of the canal near the present zone, or far from it; or that the third locks, which are partially excavated, be finished with certain changes.

It will be recalled that the canal, as it is today, includes centrally located and man-made Gatun Lake, which has an area of 165 square miles and lies plus 85 feet above sea level. Pacific-bound ships travel through a 1000- to 500-foot-wide sea-level channel about 7 miles long and are elevated to the level of the lake by Gatun's 3-lift twin-chambered locks. After passing first through Gatun Lake's buoyed channel, which is 24 miles long and varies in width from 500 to 1000 feet, and then through 9-mile Gaillard Cut, vessels are successively lowered to sea level by the 1-lift Pedro Miguel locks and the Miraflores 2-lift locks (there is a small lake at Elevation 55 between the two sets of Pacific locks). From the latter locks they go out to sea by way of an 8-mile canal.

One plan for the new passageway would put all Pacific locks at one site (like the Gatun locks) and would use small Miraflores Lake as a much needed ships' basin. The sea-level advocates argue that bombing would be less effective under their scheme. However, the war proved that the Kiel, Corinth, and Suez canals, all sea-level channels, also are apt to suffer stoppages from air attack! And the numerous flood-water dams, spillways, tidal locks, and drainage ways necessary to such a canal in that area of tremendous rainfall would be as vulnerable as are the present locks which, being deep-set in the ground, are partially immune from all but direct hits.

At any rate, the whole matter is being investigated, militarily, technically, and geographically under a $1,500,000 allotment. Presumably, the board's findings will be threshed out, and eventually Congress will act. Then construction work on an immense scale will again be in progress in "Latitude Nearly Nine." Will it be a different-type canal, located somewhere else? Or will the present one be modernized? As the Spanish say, "*Quien sabe* (who can say)?"

FIRST SHIP PASSING THROUGH CANAL, AUGUST 15, 1914

The SS "Ancon," later the World War II transport "Permanente," made the initial official trip through the "Big Ditch" and also led the line at the twenty-fifth anniversary celebration. Once called "The Bridal Special," she resumed that role recently by bringing 250 GI brides and their babies from New Zealand.

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[*] Major, U. S. A., Ret. Twenty-eight Panama Canal years.

Crimmins and Morrison Win Moles' Construction Awards

THOMAS CRIMMINS

HARRY W. MORRISON

THE annual awards "for outstanding construction achievement" by The Moles, New York organization of tunnel and heavy-construction men, will go this year to Thomas Crimmins, third-generation member of the New York contracting firm bearing his name, and to Harry W. Morrison, president and general manager of Morrison-Knudsen Company, Inc., of Boise, Idaho. Mr. Crimmins will receive the member award and Mr. Morrison the nonmember award. Citations and bronze plaques will be presented to them on February 5 at The Moles' annual dinner in New York.

Colonel Crimmins (he gained the title in World War I) has been a leader in the development of underground construction in New York City and is the accepted dean of Gotham's contractors. A native New Yorker and graduate of Harvard University (1900), he is president of the Thomas Crimmins Contracting Company, which was founded by his grandfather in 1848. The concern specializes in foundations, tunnels, and other excavation work. It built New York's first cable-car lines, and has provided foundations for many of the city's notable buildings—including the Equitable, Graybar, Paramount, and R. H. Macy & Company—for the Ritz Carlton Hotel, and for the Hellgate power station of the Consolidated Edison Company. It handled the pier-foundation work for the Henry Hudson Bridge, drove sections of the Catskill Aqueduct, and built the Long Island Plaza of the Queens-Midtown Tunnel.

After receiving his civil-engineering degree at Harvard, young Tom joined the Crimmins organization as assistant to his Uncle Thomas in 1900, and four years later, at the age of 24, became its president. In 1916 he enlisted as a private in the New York National Guard and, after service on the Mexican border, was commissioned 2nd Lieutenant in the 22nd Engineers which, after the outbreak of World War I in 1917, became the 102nd Engineers. Crimmins went to France with that outfit, became its commander with the rank of colonel and received a citation for meritorious service.

Since 1865 the Crimmins Company has specialized in underground work mainly in the metropolitan district of New York. Seldom have its activities been carried on above street level. Manhattan Island has been punched and probed by the molelike operations of this firm until it holds no subsurface secrets. As a result of these delvings and burrowings, Thomas Crimmins has become an expert on subterranean New York. During the early days of street-railway construction in New York City, Crimmins recalls how he covered miles of cable-car trackage on horseback. Before the days of the motor truck, horses were an important item of a contractor's haulage facilities, and at the turn of the century the Crimmins organization kept large stables to house its animals.

In addition to his contracting work, the Colonel is interested in a realty operating company and is a director of several hospitals and corporations. He founded the Harvard Engineering Society and in 1900 helped organize the Contractors' Protective Association that is designed to safeguard owners and the public against unscrupulous contractors. He is a director of the Regional Plan Association of New York and a pas president of the General Contractor Association of New York.

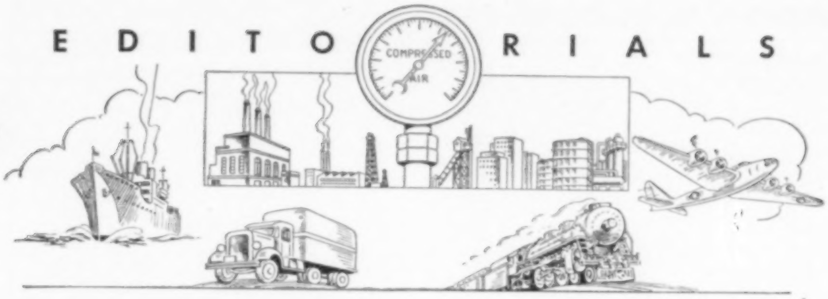
From water boy to head of what is probably the nation's biggest construction firm has been the range of Harry W. Morrison's career. Born on an Illinois farm in 1885, he went to work for Bates & Rogers Construction Corporation, Chicago, Ill., in 1902, after finishing a business-college course, later becoming a timekeeper. From 1906 to 1912 he was with the U. S. Bureau of Reclamation and during that period obtained a civil-engineering degree from a correspondence school.

In 1912 Morrison joined Morris Knudsen as partner in a contracting venture that was destined to become one of the most successful in American construction history. When Boulder Dam was up for bidding he was instrumental in combining a group of contractors to take the job under the name of Six Companies, Inc. That move set the pattern for successive combinations that have built many great projects in the West and successfully carried out the incredible construction jobs at home and overseas required by World War II.

Today Morrison-Knudsen is working in China, the Pacific, Alaska, Mexico, Canada, Afghanistan, and Brazil. The firm, with headquarters in Boise, and branch offices in San Francisco, Los Angeles, Seattle, and New York, holds scores of contracts throughout the United States for dams, railroads, irrigation projects, power plants, logging, strip mining, and buildings. It is also engaged in cement, steel, and equipment manufacturing. Currently under construction by Morrison-Knudsen are Cascade and Anderson Ranch dams in Idaho, Kortes Dam in Wyoming, John Martin Dam in Colorado, Davis Dam in Arizona, Ross Dam in Washington, and Dale Hollow Dam in Tennessee.

All these far-flung activities are directed by Harry Morrison, designated by an admiring high-ranking Navy officer who worked with him on war projects in the Pacific as "one of the greatest builders the world has ever seen." Morrison selects capable men to manage his operations, and their loyalty to "the boss," as they reverently call him, is traditional. Yet he takes a personal interest in every job. His concern for the welfare of all employees, from laborer to project manager, is inspirational in a reputedly hard-hearted industry. Home-office work irks him, so he slips away whenever possible to get out on the job, for construction operations are a passion with him, attention to details and to safety an obsession.

EDITORIALS



FIRM-PRICE POLICY

THE conversion of industry from wartime to peacetime operations involves solving many problems. Government control was probably necessary during the war to get the job at hand done effectively and on time. In a free economy such as ours, however, such control is highly undesirable in normal times and industry in general hailed its removal with satisfaction. Nevertheless, the transition to decontrol inevitably produced some difficulties that have to be ironed out before the nation can get back to a healthy economic condition. Among the undesirable features in the aftermath of control is the practice of affixing price-protection or escalator clauses to contracts calling for delivery of products at some future date. Fortunately, a movement to eliminate them is now underway.

During the war period, prices of manufactured products were frozen by the Office of Price Administration. Manufacturers were consequently unable to establish prices that truly reflected their current costs. The problem thus imposed was especially acute in the heavy-machinery field where many weeks or even months often elapse between the taking of orders and the delivery of the machines or equipment called for.

To protect themselves against possible losses, manufacturers began in 1945 to write into their quotations and sales contracts so-called escalator clauses that gave them some latitude in adjusting their final prices to customers in accordance with their own increased costs. This soon became general practice and it was continued after OPA's decontrol order was issued because that action set in motion a spiral of rising materials and labor costs that added to the existing uncertainties.

This method of doing business obviously works against stabilization of prices and postpones the time when the nation can regain a sound economic footing. It is especially desirable to have stable prices of capital goods because they are essential equipment for all the many types of production that support a large proportion of the nation's wage earners and turn out the countless things we all consume. It is important therefore to halt the inflationary cycle by erecting barriers against further price increases.

A step in that direction was taken last month by Ingersoll-Rand Company when it announced that it was thereafter eliminating the escalator clause from its contracts and quoting firm prices for its products, thereby returning to the normal method of doing business that was practiced before the war. Its lead was quickly followed by several other large industrial concerns. In a statement issued by Ingersoll-Rand officials, the reasons for the decision were explained as follows:

"In announcing firm prices in the face of generally rising costs, we realize that we are taking a risk. However, we feel that industry might be taking a greater risk from a long-range standpoint by prolonging a situation that tends to keep our economic balance upset.

"Consequently, we decided to make the move at this time, believing that our customers would welcome it, and in the hope that our action might be a step in the establishment of a sound general policy."

•

HE MADE DESERTS BLOOM

BOULDER, Grand Coulee, Shasta and virtually all the other irrigation dams in the western part of the nation may well be considered monuments to the memory of George Hebard Maxwell, who died in Phoenix, Ariz., last month at the age of 86. Mr. Maxwell was a great crusader for the irrigation of our arid lands and was given credit for bringing about the organization of the U. S. Bureau of Reclamation although he was never a government employee.

Roughly one-third of the country normally receives insufficient rainfall during the growing season to raise crops. Yet two great mountain ranges, the Rockies and Sierra Nevadas, are natural reservoirs for the retention of snow that melts in the summer and runs off in rivers that pass through these sparsely watered areas. Colonizers early learned to divert some of this run-off to their lands. There are ruins of irrigation works in the Southwest that predate recorded history. The first white explorers found some of the Indians practicing irrigation, as their ancestors had done before them.

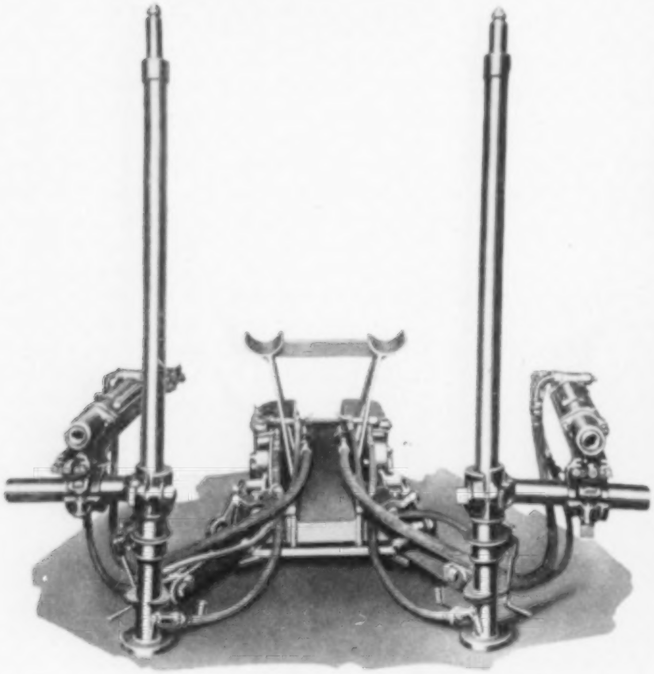
Modern irrigation began in 1847, and for the next 50 years was regarded solely as the concern of private enterprise. Many laws were passed to encourage it, but few of them took account of the public's interest in the water. Colorado was the first state to assume administrative control of its streams, and until the beginning of the century the Federal Government showed little concern in the matter. By 1890 the science of irrigation was well advanced, but the building of large dams and canal systems was beyond the financial resources of private individuals.

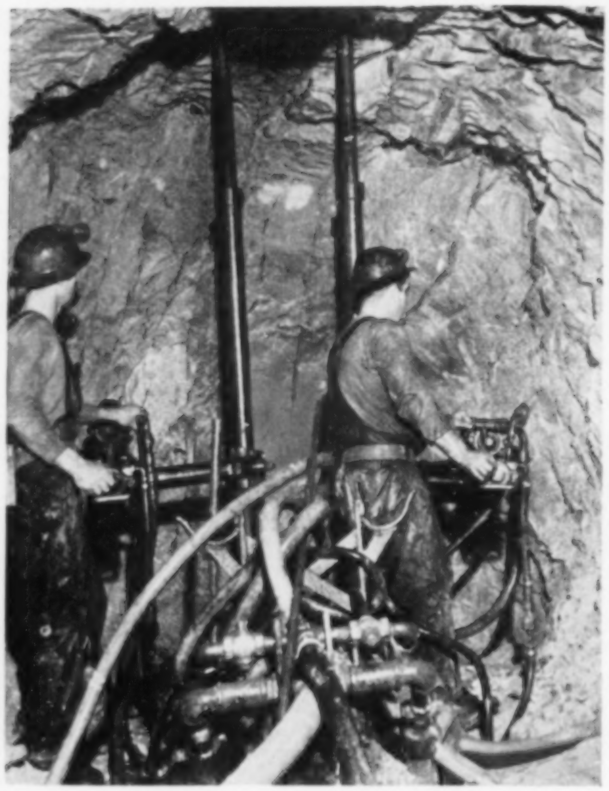
It was during this period that Mr. Maxwell began his campaign. The son of a California Forty-niner, he was educated as a lawyer, but gave up his practice to push the cause of reclamation. In 1899 he organized the National Reclamation Association and set out to bring water to 1,000,000 acres of Arizona desert. He won the support of President Theodore Roosevelt with the result that, on June 17, 1902, Congress passed the Federal Reclamation Act. This measure made irrigation the concern of the national Government and placed its administration under the Department of the Interior. Since then the department has been the principal and almost the sole agency for the development of irrigation in the arid states. Under its Bureau of Reclamation, the area of our irrigated land has attained second place among all countries, being exceeded only by India.

The Bureau has become one of the nation's foremost engineering and construction agencies and also one of the easiest on the taxpayer's pocketbook. Its policy is to sponsor only projects that are self-liquidating; and, in most instances, contracts under which the water users will repay the construction costs are signed before operations begin. During 1946 it awarded contracts totaling $158,160,000 in work and equipment and completed five jobs. At the year's end it had 41 active construction projects underway and was operating as many as 52 irrigation and power developments.

Mr. Maxwell organized the Salt River Valley Water Users Association in Arizona in 1903 and succeded in getting the Government to build Roosevelt Dam. Since then, Federal-sponsored undertakings have reclaimed millions of acres of arid land, thereby not only providing living places and means of livelihood for thousands of persons but also adding importantly to the nation's supply of foodstuffs.

Drill Jumbo Features Air-Operated Columns





RAIL CAR, COLUMNS, AND ACCESSORIES

With a mounting of this type drillers are spared all the heavy work of carrying columns and arms, drifters and steel. Cars may be built at mines to meet specific conditions. The one shown at the left was designed for an 8x10-foot heading. The column piston has a 2¾-foot extension and is provided with a stop so that 45 inches of the piston length always remains inside the column for support. Maximum spread of the column arm with swivel center 12 inches from center line of car is 64 inches. Other picture shows mounting in operating position.

NO HEAVY loads to carry, a reduction in set-up time required by hand methods, and more footage per shift, are some of the advantages claimed for the air-operated drill-jumbo mounting, DJM for short, recently announced by the Ingersoll-Rand Company. The unit consists essentially of twin air columns, each provided with a column arm and attached to a mine car through linkages. The latter are flexible, and permit driving headings of varying widths and turning headings, if desired. Mounting, together with drifters and hose in place, is folded back compactly on carriage for transportation, and column footpieces are hinged in such a way that force of gravity helps drillers pull columns upright at the heading.

Simply turning on the air forces column pistons firmly against the roof, eliminating blocking. The arms are moved up and down without exertion by hand cranks and permit drifters to swing freely in both directions. The whole assembly is held rigidly by a force of 600 pounds, and creeping and twisting are prevented by locking linkages and columns securely to the car. As a result, drifters can be fed to the face properly, pistons hit with full force and without cushioning, and there is less wear on working parts. The average saving in set-up time, compared with the usual type of mounting, is said to be 1¾ hours per shift.

Shot Peening Increases Durability of Metal Parts

SHOT peening will greatly increase the service life of engine cooling fans, exhaust-valve rocker arms, and many other parts of steel machinery, according to a report prepared for the National Defense Research Committee by R. L. Mattson and J. O. Almen of the Research Laboratories Division, General Motors Corporation. Experiments on which the report is based were conducted over a 2-year period.

Numerous parts, as well as bar-stock test specimens of steel and other metals, were given the shot treatment and then studied. Primary interest was in fatigue durability, but other properties such as static strength, impact resistance, hardness, friction, corrosion resistance, surface roughness, and surface failures also were tested. It was discovered that shot peening lengthened the service life of torsion bar springs by from 700 to 900 percent and trebled the durability of engine cooling fans.

Shot-peened exhaust-valve rocker arms were found to stand up several times as long as polished ones, and the peening of undersized rocker arms made them equal in this respect to unpeened polished rocker arms of standard size. Peening also imparted greater service life to some steel gears, as well as to specimens of aluminum-alloy sand castings, cold-drawn nickel and monel, and soft inconel. It was determined that shot peening permits manufacturing springs from steel harder than that normally used for the purpose. Several types of machine parts gave inconclusive or negative results. The durability of a tractor final-drive pinion was reduced by about 60 percent, as peening caused pitting that induced failure.

Shot peening consists in cold working metal by pelting the surface with shot by means of equipment that is basically the same as that used in shot blasting metal to clean it. The shot acts like myriads of tiny hammers that compact the surface and bring about beneficial structural changes.

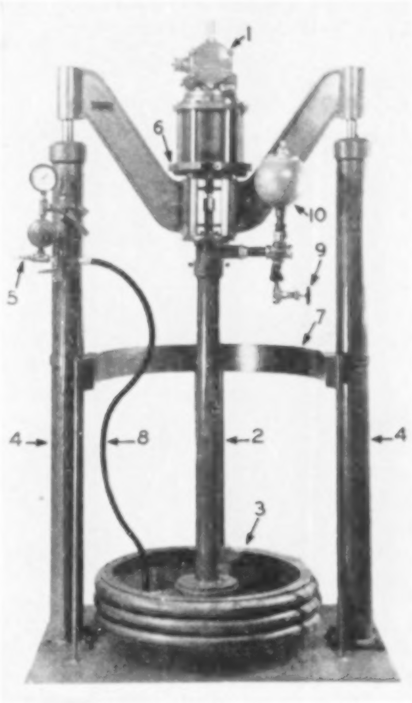
The Mattson-Almen 134-page report is sold by the Office of Technical Services, Department of Commerce, Washington 25, D. C., in either photostat or microfilm form at $9 and $3, respectively.

Pneumatic Dispenser for Heavy Fluids

FOR discharging heavy fluids from standard open-head, 55-gallon drums used in connection with spray or similar operations, Dirkes Industries, Inc., has announced a new combination elevator and pump. The unit consists essentially of an air-motor assembly mounted on top of a pump-tube assembly, of a resilient follower or wiper that fits snugly in the drum and which is attached to the lower end of the pump tube, of an elevator made up of two vertical air cylinders whose pistons support a yoke from which the pump is suspended, and of a band that holds the drum in position. Air pressures required to operate the unit vary with the viscosity and temperature of the material, speed of delivery, and length of the discharge hose and range from 20 to 70 pounds for the elevator and from 35 to 70 pounds for the pump.

In service, the yoke is lifted by admitting air to the side cylinders, the drum is set on the base plate, and the follower is brought in contact with the free surface of the contained fluid. Some installations have a bleeder valve to exhaust any excess air trapped between the fluid and the wiper that would prevent the latter from emptying the drum. With these preparations made, the valve that supplies the pump with air is opened, causing the follower to descend and to force the material out to the spray nozzle or other applicator.

By means of an air accumulator it is possible, it is claimed, to feed the fluid without pulsations, to furnish an extra volume of compressed air close to the discharge hose, and to operate the unit at lower pressures than would otherwise be the case. Air at 100 pounds pressure is maintained in the accumulator by a hose and chuck such as are used in charging automobile tires. When a drum is to be replaced, air is fed to the wiper by a separate line to break the vacuum that holds it to the bottom and at the same time to help the pneumatic elevator carry the pump assembly to the reloading position.

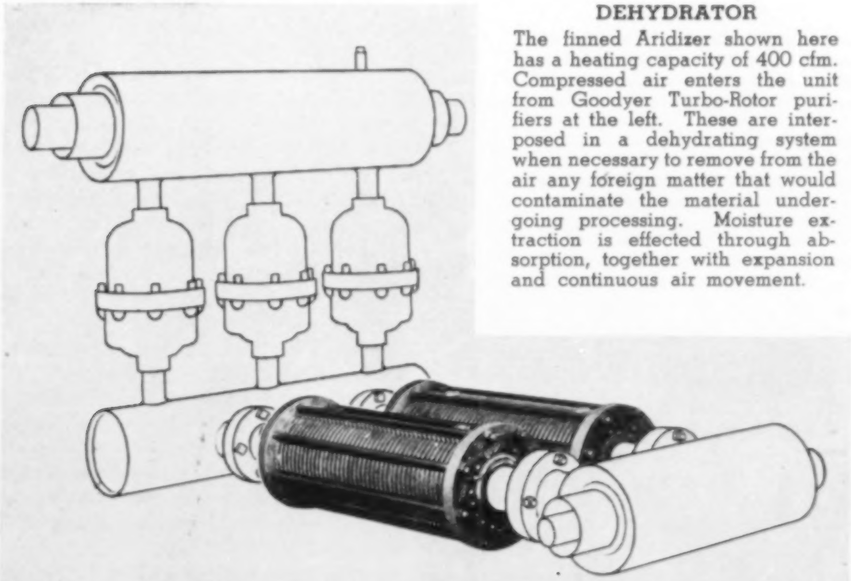


EMPTIES DRUMS

With this elevator-model air pump, the drum itself is not put under pressure. The only air that is admitted serves to break the contact between the follower and the bottom of the drum when empty. 1- Air-motor assembly; 2- pump-tube assembly; 3- follower or wiper; 4- air cylinders; 5- air inlet to cylinders; 6- pump air inlet; 7- drum hold-down band; 8- air line to follower; 9- bleed valve; 10- air accumulator.

Compact Heater for Dehydrating System

A SMALL, compact unit for heating compressed air, or other gases, or for superheating steam for purposes of dehydration, has been announced by Goodyer Industries, Inc. The Aridizer, as it is called, is based on the heat-transfer principle and is designed for use especially in food-processing plants, as well as in printing establishments, and by rubber, chemical, and petroleum industries. The unit is of bilateral-fin construction and, according to Goodyer, permits complete control of the degree of moisture extraction and effects dehydration of the product at considerably lower temperatures than does the conventional drier of the space-heater type. Because of this, and the continuous movement of the drying medium around the particles of the material undergoing processing, the resultant product is not discolored from burning, and food retains all essential elements. Heating may be done by oil or gas equipment or by electric calrods. In the latter case, the Aridizer can be made an integral part of the compressed-air, gas, or steam system. Test and service installations have proved that temperatures up to 1000°F. can be maintained, with leaving temperatures controlled to within plus or minus one degree.



DEHYDRATOR

The finned Aridizer shown here has a heating capacity of 400 cfm. Compressed air enters the unit from Goodyer Turbo-Rotor purifiers at the left. These are interposed in a dehydrating system when necessary to remove from the air any foreign matter that would contaminate the material undergoing processing. Moisture extraction is effected through absorption, together with expansion and continuous air movement.

Fiber-glass Diaphragms

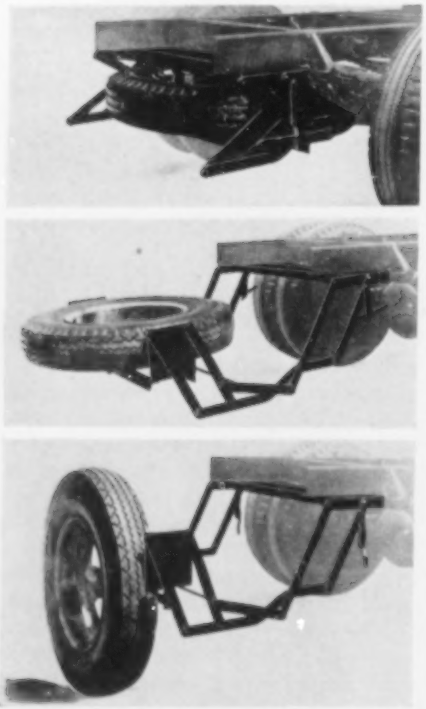
GOATSKIN, special goatskin at that, was used before the war for the manufacture of the supersensitive diaphragms required for low-pressure measurement and control equipment. Only leather from animals raised high in the Himalaya Mountains was acceptable for the purpose because it was not punctured by mosquitoes and blemished by ticks and other pests that cannot endure the Hump's rigorous climate. With the supply from that source cut off, something equally durable had to be found, and it has been, we are told, in Neoprene-coated fiber glass. The substitute material was developed by the Askania Regulator Company and is said not to sag or stretch and to be nonporous, impervious to gases and vapors, and resistant to alkalies and acids. In short, diaphragms made of it outlast the goatskin type and are just as sensitive.

Industrial Notes

Spray-painting on a wholesale scale is planned by the government of Saskatchewan, Canada. An air-spray outfit belonging to the province is to make the rounds and refurbish something like 80,000 public buildings and farmsteads.

Silicon steel, which is used in the manufacture of electrical equipment, is extremely brittle and therefore hard to work. To prevent loss through breakage in slitting sheets of the metal, one company has installed a burner in front of the machine. This unit is connected to the shop air and gas lines and is adjusted to heat the steel to just the right working temperature as it passes over it on its way into the slitter.

Anyone who has had experience in changing truck tires knows that they are heavy to lift and handle. To relieve drivers of the back-breaking work of transferring first the "spare" and then the "flat," a Californian in the truck-tire business has invented an extensible carrier that is bolted either at the rear or side of the vehicle under the chassis frame. The spare fits in a swiveled cradle, which is pulled clear of the truck body by releasing holding clamps that are designed to prevent vibration of the carrier when on the road. While still held in the cradle, the tire is tilted until it rests on the ground in an upright position, ready to be rolled away after removal of a clamp. The flat is handled in the same way in inverse order. The whole job can be done easily and safely by one man, and unit is constructed to withstand a load stress equal to four times the weight it is designed to support. It is known as the Ted Tire Carrier and will be distributed through truck dealers.



CRADLED-PULLED OUT-TILTED
The truck or bus tire carrier that prevents lifting and straining when changing a "flat." There are two models designed for 8.25x20 and 11x22 tires weighing 72 and 93 pounds, respectively.

An advantage claimed by Hi-Bond over conventional reinforcing steel is that its reverse-helical cross ribs joined to two lengthwise straight ribs provide a nonslip surface that facilitates setting-up operations. In building Mt. Sinai Hospital in Chicago, Ill., the contractor found that a single loop sufficed to hold bars securely in vertical construction, while those for slab and beam sections did not require a tie at every joint. He reports savings in wire and labor of as much as 25 percent.

Chemists have for years sought to make synthetic glycerin on a commercial scale. In this they have now been successful, it is reported by the Shell Chemical Corporation, which is planning to build a $7,000,000 plant for its manufacture at Houston, Tex. Glycerin has many medicinal, industrial, and wartime uses, and is normally obtained from animal and vegetable fats. The synthetic product is made by treating stable supplies of the chemicals propylene, chlorine, and caustic soda. It is said to be pure and of the same high quality as glycerin obtained from natural raw materials as a by-product in the manufacture of soap.

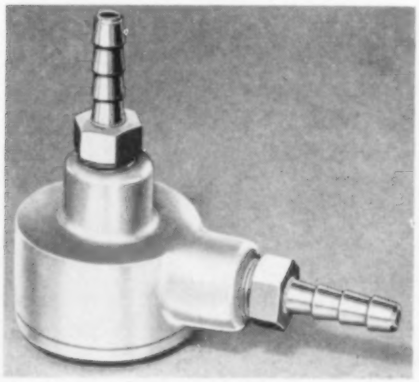
In our December, 1945, issue we described the Hauck thawing pits for coal cars to prevent delays in dumping customarily experienced in winter. Since then the company has designed multiple high-pressure, air-oil systems to serve 2-, 3-, and 4-hopper cars to speed up operations. One 6-pit installation at the Hauto Coal Company's new breaker is divided in groups of two and four on one track for 2- and for 3- or 4-hopper cars, respectively. It is expected to thaw twenty cars of "culm-bank" coal per shift during the coldest weather. This is one of 35 now in use in the anthracite region of Pennsylvania.

Center obstructions in bores are no obstacle to the new micrometer introduced by Tubular Micrometer Company. As the accompanying illustration shows, this precision instrument for measuring inside diameters is designed to fit around boring bars, thus eliminating their removal. The steel frame is of the hollow box type for rigidity and lightness and is evacuated to dissipate hand heat that would cause expansion and contraction and affect micrometer readings. Frames are plated with copper, nickel, and heavy chrome to resist wear and perspiration; the spindle is of hardened and ground tool steel; graduations on the barrel and thimble are large for easy reading; and adjustment for wear is permissible at three points. The standard range of sizes of this over-the-bar micrometer is from 8 to 28 inches for bar diameters from 4 to 8 inches, and special instruments for larger bores are obtainable. Each fits around bars of varying sizes. The one shown is a 13½- to 18-inch set and covers obstructions up to 7½ inches in size.

A huge dragline excavator that can raise itself on "crutches" to swing over soft ground recently started work for the Maumee Collieries Corporation. Built by Bucyrus-Erie, the unit has a bucket capacity of 25 cubic yards, or 37 tons of earth and rock overburden, and is said to deposit the material fully 350 feet away from the point where it is picked up. When at work, the dragline rests on a large circular tub or platform. When changing location it advances in steps by means of immense boats or shoes. These are at the sides of the machine, and by lowering and raising them successively, lift the dragline from the tub, move it forward, and again allow it to come to rest on the tub. These operations are repeated until the new working site is reached.

Frost damage to pavements in regions where ice and snow are heavy is preventable, according to the chief engineer of the Oregon State Highway Commission. It is the experience of that department that the subgrade is usually responsible for such damage and that it can be largely eliminated by using a porous material of adequate depth, depending upon the locality. In constructing roads through mountain passes and in other frigid areas, it is now the practice in that state to lay a course of crushed rock or gravel 30 and more inches deep. A subgrade of this type provides large interstices and gives capillary action little chance to draw moisture into it from the underlying ground. It is the expansive force of freezing water that causes frost boils in pavements, and capillary action is inversely proportional to the size of the interstices. It is claimed that highways with a base of this kind have withstood the effects of freezing and thawing for several winters even in the coldest sections of Oregon.

Mead Specialties Company has announced a new kind of exhaust valve for use with pneumatic cylinders. It is a compact little unit that acts like a bellows to expel the air quickly. Valve opens automatically as soon as the air supply is shut off, thus speeding up the return stroke of the piston and, incidentally, production. Under actual operational-procedure tests it increased the number of strokes per minute 67 percent it is claimed, or from 75 to 125. Unit can be attached directly to the cylinder with a ¼-inch pipe nipple, or cut into the air hose adjacent to the cylinder. Its over-all dimensions, exclusive of the nipple, are: Body diameter, 1¾ inches; height, 1½ inches; and length, 2¼ inches.



At the recent meeting of the National Metal Congress in Atlantic City, the Tocco Division of The Ohio Crankshaft Company exhibited an inductor gun that looks like a portable drill and weighs about as much. The unit reverses the usual procedure of taking the work to the induction-heating machine and is designed for bulky, odd-shaped pieces and short runs that cannot be conveniently handled by coils of the conventional type. The gun is operated by a trigger and can be used with standard machines to which it is connected by power cables. These, together with control wires and water inlet and outlet, are carried in one flexible lead. The multiple-turn coil in the body of the gun is water-jacketed to carry off excessive heat.

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France Metal Packing creates very slight friction because it rides on the rod as a lubricated metal to metal contact. Why use materials that are known to develop high friction? Where operating conditions call for a non-metallic packing, France furnishes either carbon or carbon bakelite rings—both especially developed for the low co-efficient of friction. The special materials and fine workmanship applied to the outstanding France Packing designs result in long packing life and negligible maintenance effort.

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Industrial Literature

The Capewell Manufacturing Company, 60 Governor Street, Hartford 2, Conn., will send to anyone interested a copy of its handbook on hack saws and band saws. The information in it is intended primarily for the saw operator and is designed to help him get more and better service from the blades.

A 12-page booklet on Water Conditioning Chemicals and Equipment has been prepared by Allis-Chalmers Manufacturing Company for the guidance of power-plant operators. It outlines boiler feed-water test procedures, tells how to obtain samples, and discusses the care of testing equipment and the reporting of results. Copies can be had by requesting Form 28X6385 from the company at Milwaukee 1, Wis.

A small group of public-spirited engineers, members of the electrical committee of the National Fire Protection Association, has worked almost anonymously for 54 years to improve safety wherever electrical equipment is concerned. Their findings are the basis of the NFPA Electrical Code, which is a collection of rules governing the installation and, to a certain extent, the use of electrical equipment. The 1947 edition is a 408-page, cloth-bound volume that specifies in detail how electrical materials, devices, fittings, and appliances should be installed and maintained. It is obtainable from the association, 60 Batterymarch Street, Boston 10, Mass. Price $2.00.

Numerous types of conveyors, or powerized tables, are utilized in various ways by modern industry. They make it possible to route parts through a production department in a direct line, minimizing lifting, detours, and storage. Portable conveyor systems having the trade name of Unitables and sold by Island Equipment Company, 101 Park Avenue, New York 17, N. Y., are described in Bulletin PF8, which is available without charge.

Bellows Senacon Company, 798 North Main Street, Akron, Ohio, uses a novel method for publicizing the effectiveness of its air cylinders in speeding production of various kinds. It issues what it calls Foto Facts File sheets, each of which illustrates a specific operation, describes it, and points out the benefits that have resulted from its adoption. These industrial case histories involve various operations in different manufacturing fields. The first of a new series is now available for distribution.

To the layman, hose is hose, but hose manufacturers and users divide hose into many kinds, each of which is designed for a specific purpose and made accordingly. One of these special types is that used for sandblasting. A new leaflet on Goodrich sandblast hose points out that it is compounded to give maximum resistance to sand or other sharp abrasive materials that pass through it. To reduce friction and the generation of static electricity, its inside walls are made as smooth as possible by forming them on polished mandrels. Copies of the sheet, No. 4440, may be had from B. F. Goodrich Company, Akron, Ohio.

Wherever explosion hazards exist, the transmission of electricity for operating indicating instruments is not permissible. These conditions prevail in the petroleum and chemical industries, and to meet them The Brown Instrument Company, Philadelphia 44, Pa., has developed a pneumatic transmission system that has no electrical circuits of any kind. It is applicable to instruments designed for indicating or record-

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ing temperature, pressure, flow, and liquid level. Catalog No. 5902 of the Brown company describes and illustrates it in detail.

Industry now recognizes the value of human eyes to such an extent that protective equipment has been made available to meet almost any contingency that may arise. Goggles are designed expressly for given operations, and there are so many different types that an 8-page bulletin, No. CE-29 is required to describe those made by Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh 8, Pa.

During the early part of the war, engineers engaged in testing military airplanes wanted to record temperatures at around 100 points in as many seconds, but there were no instruments that would do this. To fill the need, an electronic strip-chart potentiometer was developed by The Brown Instrument Company and was used during test flights on all classes of craft from the largest bomber to the single-seater fighter plane. Since then it has served similar purposes in many industrial processes. A descriptive catalogue, No. 15-10, may be obtained upon request from the manufacturer at Wayne and Roberts Avenues, Philadelphia 44, Pa.

New industries acquire a terminology all their own, and it is apt to be confusing to the layman. To overcome this difficulty in the case of the plastics and rubber industries, B. F. Goodrich Chemical Company, 324 Rose Building, Cleveland 15, Ohio, has issued a glossary of chemical names, terms, and phrases. The 12-page booklet is designed to give manufacturers, fabricators, and designers a knowledge of words associated with the production and application of plastics and nitrile rubbers.

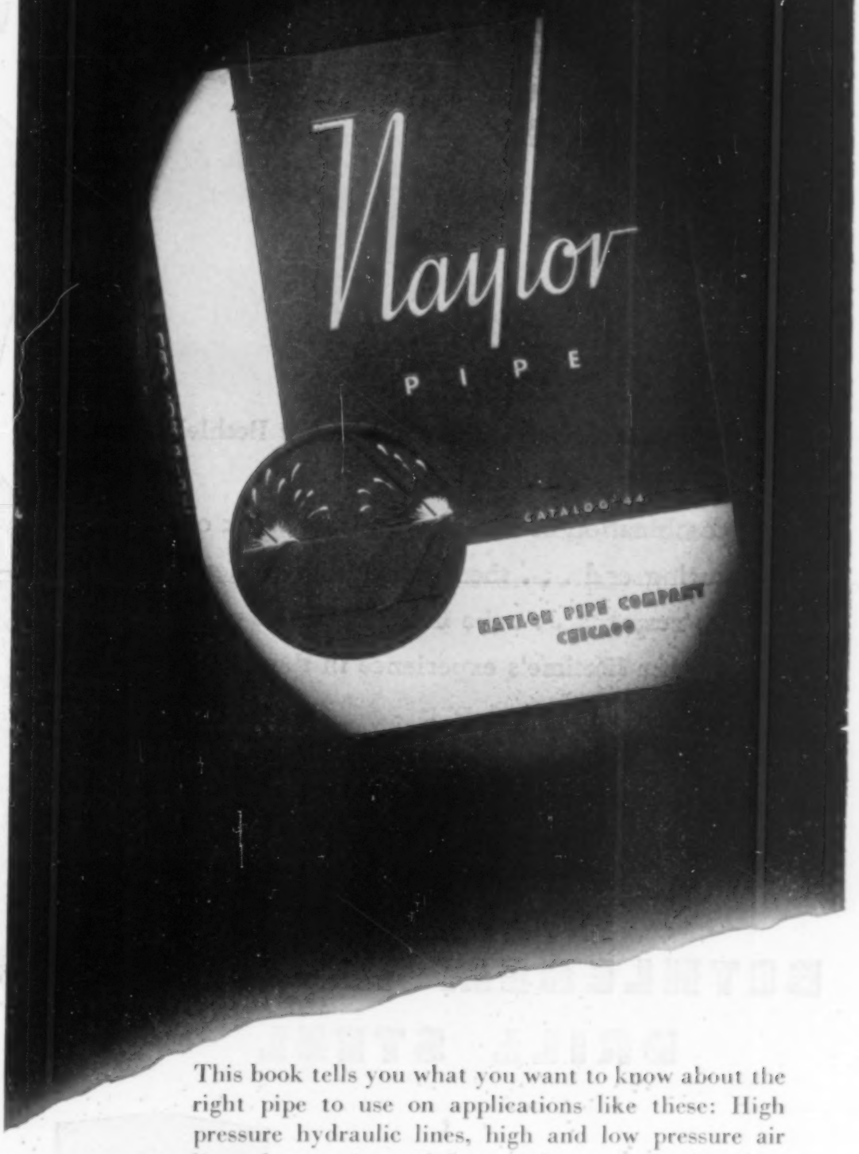
The deep-drawing of sheet metal with the aid of Carboloy (tungsten-carbide) is discussed in a new booklet, No. D-120, issued by Carboloy Company, Detroit, Mich. Numerous jobs designed to show the adaptability of Carboloy dies are described and illustrated. Among them is an outstanding drawing operation involving highly abrasive beryllium copper, and a case where one set of dies turned out 8,000,000 pieces without having to be reworked.

A Visual Index that shows industrial applications of the different forms of Bitumastic protective coatings manufactured by the Wailes Dove-Hermiston Corporation of Westfield, N. J., has been issued by that concern. It includes a large composite drawing of a typical factory that indicates where the protective material can be used to advantage in the prevention of corrosion.

To serve as a ready reference source, Sun Oil Company, Philadelphia 3, Pa., has issued a folder that lists and describes most of the important products that it makes and that can be used by industries.

Devoted to a subject on which comparatively little information has previously been available, a 144-page illustrated booklet, *Heat Treating Aluminum Alloys*, has been issued by Reynolds Metals Company, 2500 South Third Street, Louisville 1, Ky. It has been written so as to serve both the technical and nontechnical man. The first of its three sections discusses the metallurgy and heat treatment of aluminum alloys in lay language. Section 2 presents in tabular form the recommended thermal treatments for various alloys. Section 3 details technical information for the metallurgist and operating personnel. The book is available at $1 a copy.

BOOK-OF-THE-YEAR for Mining Engineers



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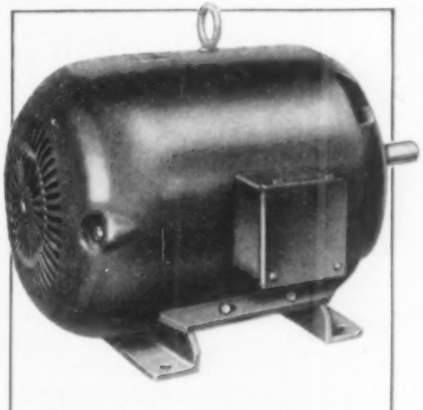

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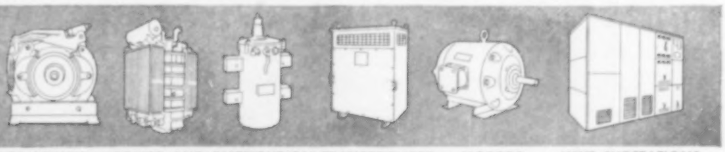

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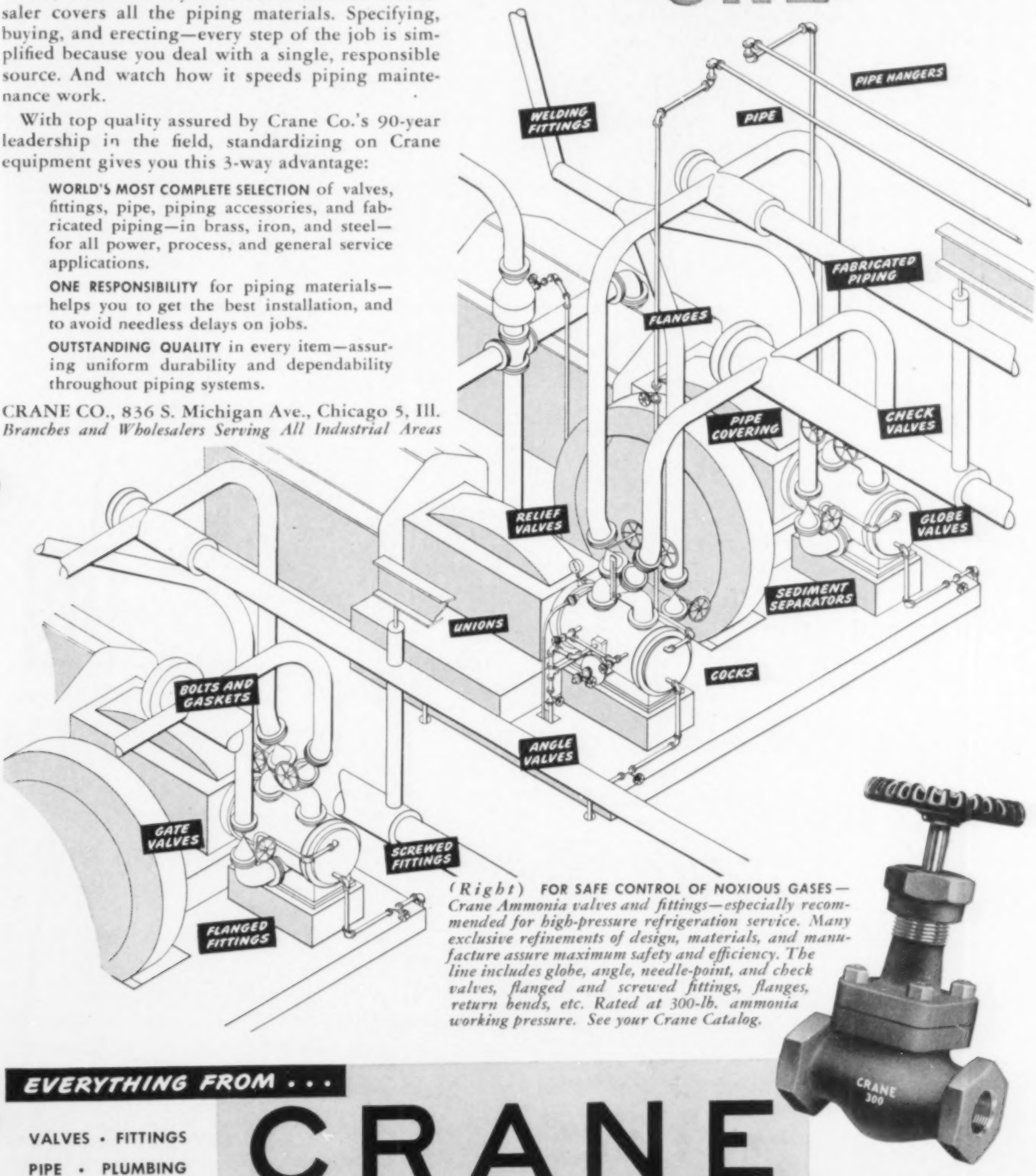
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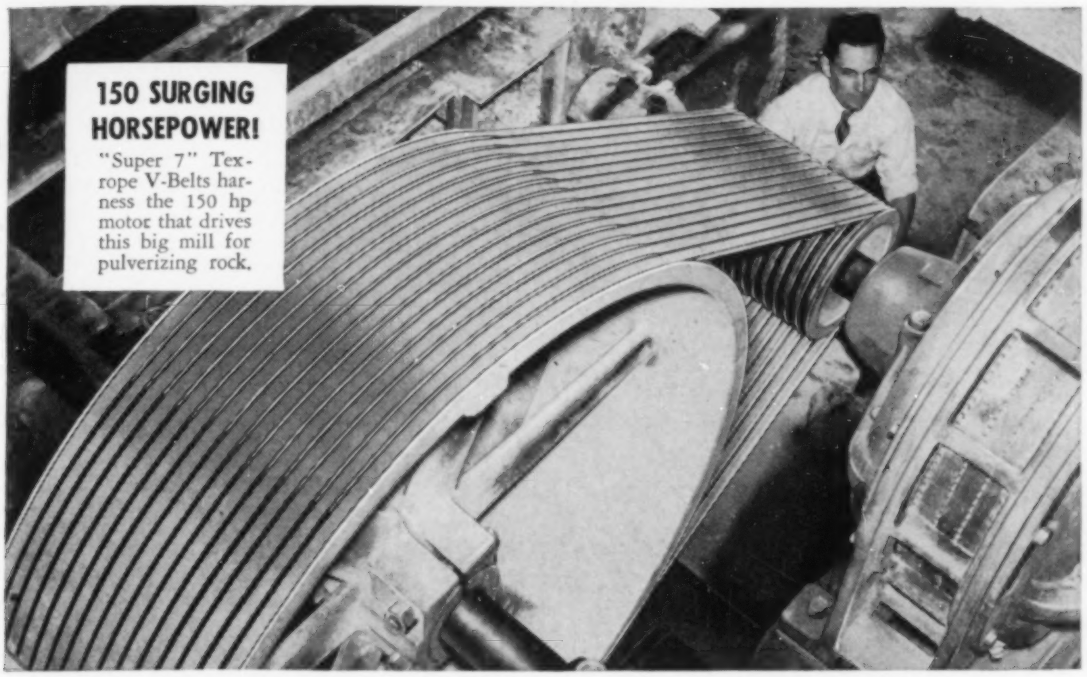
COMPRESSORS • AIR TOOLS • ROCK DRILLS • OIL AND GAS ENGINES • CENTRIFUGAL PUMPS • TURBO BLOWERS • CONDENSERS

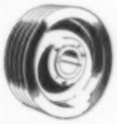


150 SURGING HORSEPOWER!

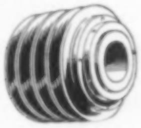
"Super 7" Texrope V-Belts harness the 150 hp motor that drives this big mill for pulverizing rock.

TEXROPE ..Greatest Name in V-Belt Drives

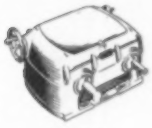
"Super 7" V-BELTS
Five Types — Sizes to suit every power transmission job.



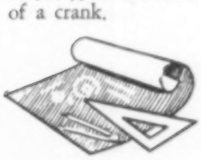
Texsteel, Texdrive, "Magic-Grip"
— sheaves in a full range of sizes, grooves.



"Vari-Pitch" SHEAVES
Exact variations in speed, stationery or motion control.



SPEED CHANGERS
Speed variations up to 375% at the turn of a crank.

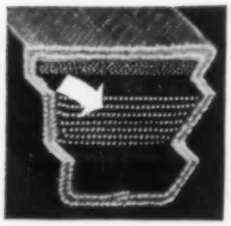


ENGINEERING
Finest V-Belt engineering talent in the world—at your call.

TEXROPE "Super 7" V-Belts result from the cooperative research of two great companies — Allis-Chalmers and B. F. Goodrich. They are sold only by A-C.

PULLING POWER

. . . one of the 7 Great Features in "Super 7" Texrope V-Belts!



1. STRONGER CORDS give "Super 7" Texrope V-Belts their great pulling power. These long-fibre, hard-twisted cotton cords have the strength of high-test fish lines. Laid row on row and imbedded in heat resistant rubber compound, they provide a powerful load-carrying element.

2. TOUGHER COVER. Rugged duplex construction protects the carcass of "Super 7" belts from wear and dirt.

3. HEAT RESISTANCE. *All* "Super 7" V-Belts are designed and built to give high resistance to heat.

4. SHOCK ABSORBING. "Super 7" construction combines great strength with the degree of resiliency necessary for long belt life and smooth power transmission.

5. PRECISION CURED in pressure molds to assure accurate section and perfect bonding of cords, cover and cushion.

6. ACCURATELY MATCHED. Every belt weighed, measured and carefully inspected before being sized and packed.

7. ENGINEERING LEADERSHIP. "Super 7" Texrope V-Belts represent 27 years of research and experience — by Allis-Chalmers, originator of the Multiple V-Belt Drive.

• • •

There are FIVE types of "Super 7" Texrope V-Belts, to meet every operating requirement: *Standard — Heat Resisting — Oil Resisting — Oil Proof* — and *Static Resisting.* Call your Allis-Chalmers office or dealer. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

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ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

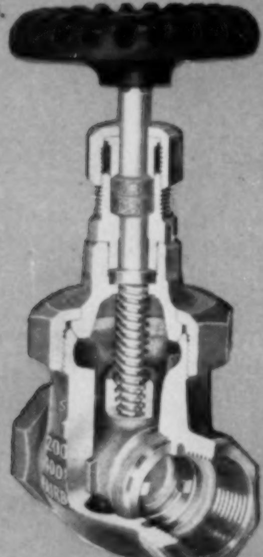
AC
1847 1947
A CENTURY OF SERVICE
to Industry
THAT MADE
America Great

Quick facts tell why fairbanks 200 lb. UNION BONNET BRONZE GATE VALVES perform better . . . last longer . . .

0236
RISING STEM WITH NICKEL ALLOY WEDGES AND RENEWABLE NICKEL ALLOY SEATS. SIZES ½" TO 2".

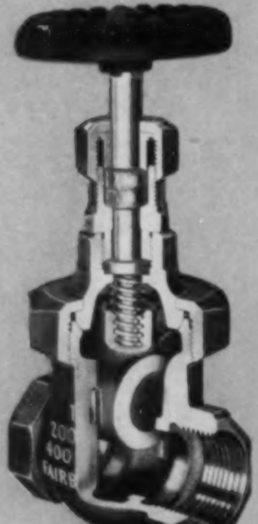
because . . .
the specially designed hard nickel alloy seats and wedges provide the ideal combination for corrosion and erosion-resistance that extends valve life, reduces maintenance costs, eliminates service interruptions.

0232
NON-RISING STEM WITH NICKEL ALLOY WEDGES AND RENEWABLE NICKEL ALLOY SEATS. SIZES ½". TO 2"



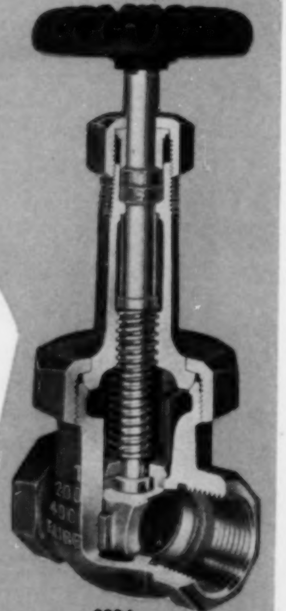
because . . .
the Union Bonnet Construction permits the easiest and quickest valve dismantling for inspection, cleaning, or replacement of parts. A heavy octagonal union nut and radial bonnet joint assure pressure tightness and perfect alignment of all parts.

because . . .
stuffing boxes are large and deep . . . filled with moulded asbestos packing and fitted with a heavy, brass follower gland. Gland is held tightly against packing by wrought brass packing nuts. Valve can be repacked under pressure when wide open.



0230
NON-RISING STEM WITH NICKEL ALLOY WEDGES AND INTEGRAL SEATS. SIZES ¼" TO 2"

because . . .
wedges are held in proper alignment by machined guides in the wedges and heavy cast ribs in valve body. Bodies and Bonnets are special cast steam bronze with reinforcing ribs for extra safety under pressure and resistance to operating stresses.



0234
RISING STEM WITH NICKEL ALLOY WEDGES AND INTEGRAL SEATS. SIZES ¼" TO 2".

For complete information about this outstanding line of valves write for Bulletin V-230. The Fairbanks Company, 393 Lafayette St., New York 3, N. Y.; 520 Atlantic Ave., Boston 10, Mass.; 15 Perry St., Pittsburgh 22, Pa.; 748 M&M Bldg., Houston 2, Texas.

American industry flows through fairbanks valves

CONFIDENCE . . . how much is it worth?

IN 1841, two years before the first telegraph line was installed in this country, and when there were but 27 states in the Union, John August Roebling was inspired with the idea of making a new kind of rope of unheard of strength and flexibility. His confidence in his idea caused him to risk everything he had on the development of his new rope.

How much is his confidence worth to Industry today, which couldn't turn a wheel without the modern wire rope?

Today, the John A. Roebling's Sons Company invests much time, effort and money in the development of improved products to keep alive the confidence of its many customers.

Roebling values this confidence as its greatest asset. That's why it offers you the greatest value for every dollar you invest . . . in *any* Roebling product.

HOW TO SAVE WIRE ROPE DOLLARS

Wire rope is a machine of many parts and, like any machine, even the finest of wire ropes can be destroyed quickly through faulty installation or improper maintenance. To insure against this possibility, Roebling established its Field Engineering Service.

Every Roebling Field Engineer has a thorough knowledge of wire rope . . . its types, its uses, its features and limitations. This knowledge plus the experience he gains in his daily contacts can be a great asset to you . . . helping you to solve those tough wire rope problems . . . giving you more service for each wire rope dollar.

Get to know your Roebling Field Engineer. Call him at your nearby Roebling Branch Office.

JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

FOR EXAMPLE—"BLUE CENTER" STEEL WIRE ROPE

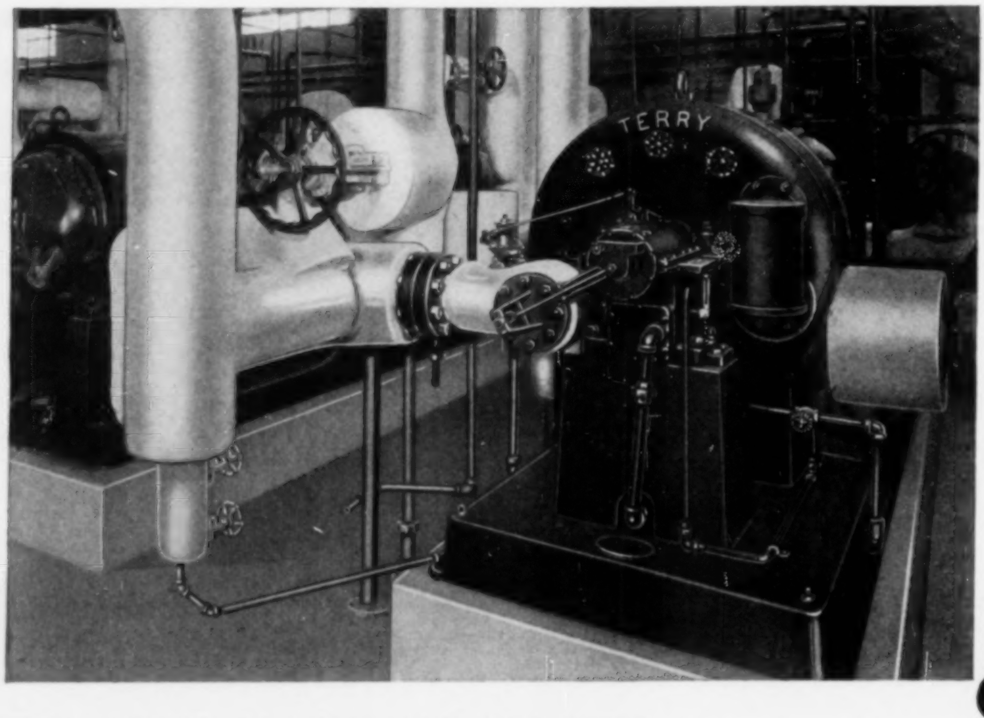
Roebling entrusts your confidence in Roebling and Roebling products to the performance of its "Blue Center" Steel Wire Rope. It is the best rope Roebling knows how to make. It is available as preformed or non-preformed, in a complete range of sizes and constructions to meet a great variety of operating conditions. Its uses are almost unlimited and its performance is consistently economical.

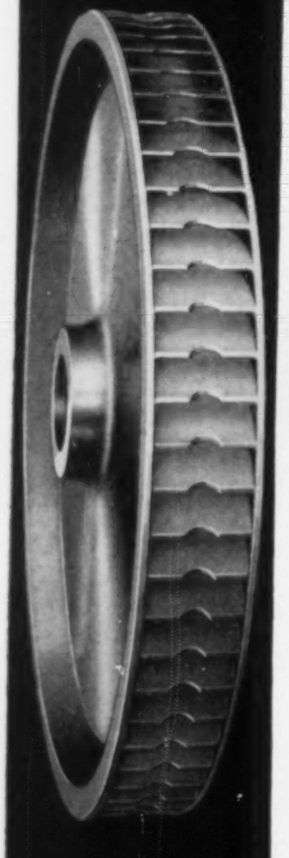
Manufacturers of Wire Rope and Strand • Fittings • Slings • Screen, Hardware and Industrial Wire Cloth • Aerial Wire Rope Systems • Hard, Annealed or Tempered High and Low Carbon Fine and Specialty Wire, Flat Wire, Cold Rolled Strip and Cold Rolled Spring Steel • Ski Lifts • Electrical Wire and Cable • Suspension Bridges and Cables • Aircord, Aircord Terminals and Air Controls • Lawn Mowers

ROEBLING

A CENTURY OF CONFIDENCE

TERRY.





GENEROUS BLADE CLEARANCES IN THIS 900° TERRY WHEEL TURBINE INCREASE DEPENDABILITY . . . .

The 290 H. P. Terry Turbine shown above is used for Boiler Feed Pump Drive in a recently completed central station. It operates with steam at 850 lbs.-900° F. and employs a Terry one piece wheel, as illustrated at the left.

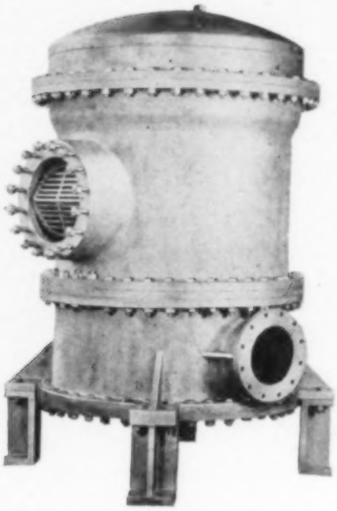
The blades of this Turbine have large radial and axial clearances. They are further protected by projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced. It is therefore impossible for the blades to foul.

The side clearance is very large - one inch - so that end play can do no damage.

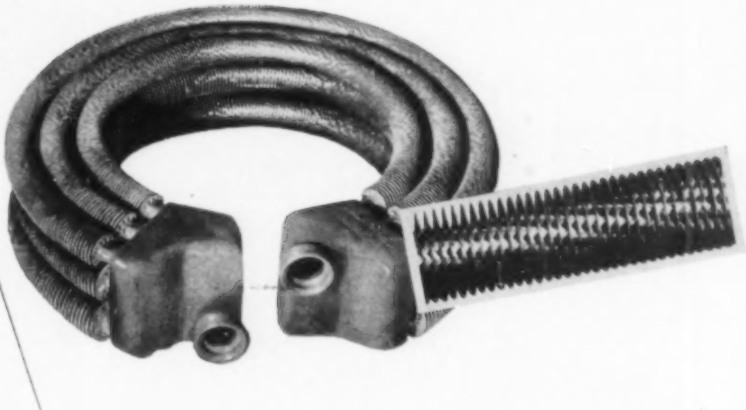
Such construction makes for dependable operation.
- Descriptive bulletins sent on request. Ask for S-116.

T-1167

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



INDUSTRIAL HEATING SYSTEM HEATER equipped with copper tubes for efficient heat transfer. Built by the Alberger Heater Company, Buffalo, N.Y. for use in large automotive plants.



COIL TYPE AIR HEATER designed to heat air from ventilating ducts. Fins of Anaconda Copper are wound and crimped on Anaconda Brass Tube. Made by Schutte and Koerting of Philadelphia.

If it's heat transfer ...consider COPPER

"HELIFLOW" COOLERS AND HEATERS made by Graham Manufacturing Company, New York, provide exceptionally high heat transfer. Equipped with coils fabricated from Anaconda Copper or Copper Alloy Tubes.

REGARDLESS of the type of heat exchanger employed, the transfer of heat costs money. Through the years copper has proved outstandingly successful—and economical—in this job.

Possessing high thermal conductivity, this time-proved metal is rustproof, highly resistant to corrosion and readily fabricated into any desired shape.

Note the three applications illustrated. Each is a good example of the use of copper in the construction of efficient, economical and durable heat transfer equipment. 46100

ANACONDA

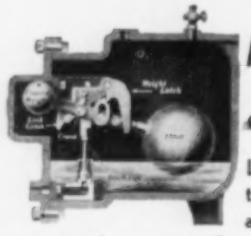
Anaconda

COPPER

THE AMERICAN BRASS COMPANY
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

Bulletin 444
shows how to

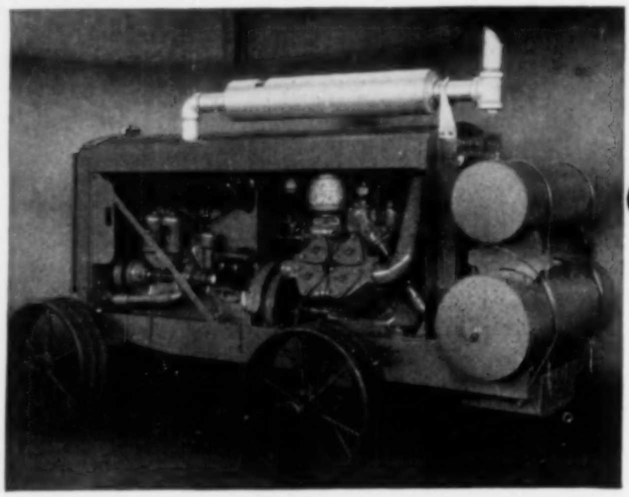
SPEED DRAINAGE
SIMPLIFY PIPING
WITH
NICHOLSON
WEIGHT-OPERATED TRAPS



Let us send you a bulletin that is being increasingly accepted as a standard reference on how to step up production by increasing the simplicity and drainage of piping systems. Bulletin 444 shows layouts for many applications of "advance-type" Nicholson weight-operated traps, as well as piston and thermostatic traps. For air, steam and gas. Pressures to 1500 lbs.

Catalog 444
or See Sweet's

W. H. NICHOLSON & CO. 180 OREGON ST.
WILKES-BARRE PA



MAXIM EQUIPPED FOR GOOD PUBLIC RELATIONS

A portable compressor is apt to spend its service life in many locations where noise is a nuisance to nearby homes and offices. It is good public relations to provide adequate silencing and good practice to choose Maxims for this job. For superior silencing of engine exhaust and intake, compressor intake, steam or air blow-off; for spark arresting or silencing with the heat recovery feature, specify Maxims. Detailed bulletins on request.

THE MAXIM SILENCER COMPANY
61 HOMESTEAD AVENUE, HARTFORD 1, CONN.

MAXIM SILENCERS

"SUBWAY"

The PAY LINE From Compressor to Drill!
ALL-SYNPLASTIC

PHILADELPHIA
SUBWAY
INC.

WRAPPED DUCK CONSTRUCTION
Sizes ½" to 1¼"

GOODALL has built into "SUBWAY" AIR HOSE all the qualities that long experience and a thorough knowledge of the service requirements specify.

The specially compounded tube is tough, long-wearing, oil-proof. The husky, high-quality duck carcass provides the extra strength for which the hose is famous; and the smooth, rugged red cover will withstand plenty of rough handling and severe abrasive wear.

Contact Our Nearest Branch or Main Office

GOODALL RUBBER CO., INC.

THE GOODALL-WHITEHEAD COMPANIES

WE ARE PARTICIPANTS IN THE OWNERSHIP AND OPERATION OF NATIONAL SYNTHETIC RUBBER CORPORATION

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HAVING TROUBLE... WITH YOUR AIR?

Air under compression is likely to carry moisture, oil or scale into expensive tools and bring them to grief. • For many years we have specialized, **pioneered** in the cleansing, drying and cooling of compressed air. Our extensive line of products contains an aftercooler, separator or automatic ejection trap that will exactly meet your need regardless of the volume of air to be processed. Every unit of recommended Murphy equipment, when installed according to directions, carries an **unconditional guarantee to completely solve your problem, or money refunded.** • Don't "baby" a bad condition! Lick it! Submit your problem **now.** There's no obligation, and you'll find our reply both prompt and helpful.

Note: In asking for our recommendation please state the approximate size of your compressed air system and explain briefly the condition to be overcome. Address Department C-12.

GUARANTEED COMPRESSED AIR PRODUCTS

AFTERCOOLERS • SEPARATORS • STRAINERS • TRAPS
SPRAY GUNS • PISTOL SPRAYERS

JAS. A. MURPHY & CO.
HAMILTON, OHIO, U.S.A.
Moisture Elimination Up To 3000 Pounds Per Square Inch

ARE YOUR PRESSES VILLAINS?
SLAVE DRIVERS?
SPENDTHRIFTS?
CHECK!
YOUR PRESSES
for efficiency ✓
for safety ✓
for increased production ✓

YOUR PRESSES *CAN* DO MORE FOR YOU!

It's a simple matter to get (1) SAFER operation, (2) more operator satisfaction and (3) more production from your presses. Just install Schrader Press Controls. Let them put compressed air to work for you—efficiently! Eliminate fatiguing leg movements, keep hands automatically away from danger zone. Thousands of Schrader Press Control Sets are in use in leading plants.

Contact your mill supply distributor or write for Catalog 4 containing details on the various types of Schrader Controls for presses. You'll save money in many ways!

1844
1947

PRESS CONTROLS

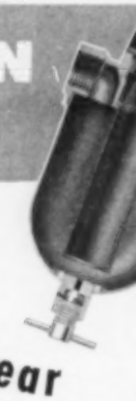
OTHER SCHRADER PRODUCTS FOR EFFICIENT AIR CONTROL

Air Valves 2,3,4-way • Air Operated Machine Controls • Air Operated Press Controls • Quick Acting Couplers • Blow Guns • Air Ejection Sets • Hydraulic Gauges

Schrader
PRODUCTS
CONTROL THE AIR

A. SCHRADER'S SON, *Division of Scovill Manufacturing Company, Incorporated,* **BROOKLYN 17, N. Y.**

NORGREN FILTERS



cut air tool wear

Knock out air-borne grit—stop early replacement of air driven tools and cylinders. Fine mesh double Monel wire screen stops scale, dirt and rust. Design and baffle action checks oil emulsion and moisture. Easy to clean. Open waste cock, blow muck out. Wide range of sizes.

Write for Catalog 400

C. A. NORGREN CO.
222 Santa Fe Drive, Denver 9, Colo.

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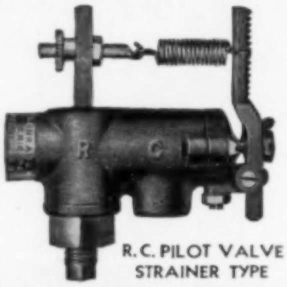
R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U.S.A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.

PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

---

For Smooth "*Roll-Over*"

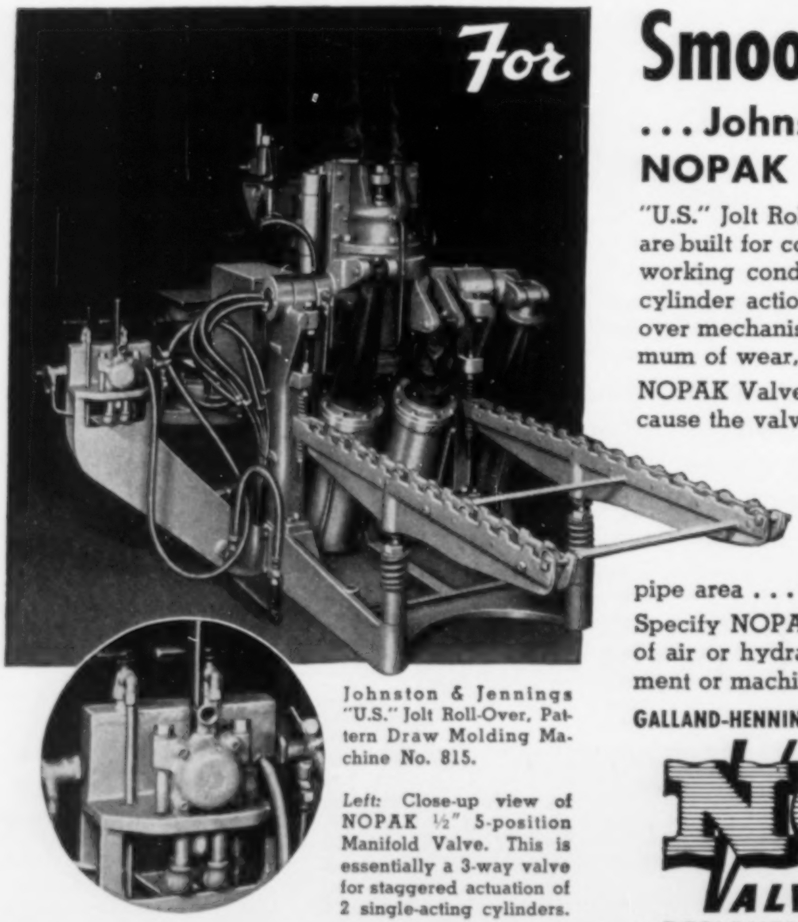
. . . Johnston & Jennings Specifies NOPAK 5-Way Manifold Valves

"U.S." Jolt Roll-Over, Pattern-Draw Molding Machines are built for continuous, rugged service under arduous working conditions. Smooth, controlled sequence of cylinder action is required to actuate the heavy roll-over mechanism hundreds of times a day, with a minimum of wear, shock, and vibration.

NOPAK Valves are ideally suited to this purpose because the valve disc rotates at right angles to the stream flow. This basic NOPAK principle provides positive control through the complete cycle of valve operation . . . from slow, gradual, throttling action to immediate opening of full pipe area . . . without damaging shock or impact.

Specify NOPAK Valves for smooth, shockless control of air or hydraulic power, either in your plant equipment or machines you build for resale.

GALLAND-HENNING MFG. CO., 2759 S. 31st St., Milwaukee 7, Wis.



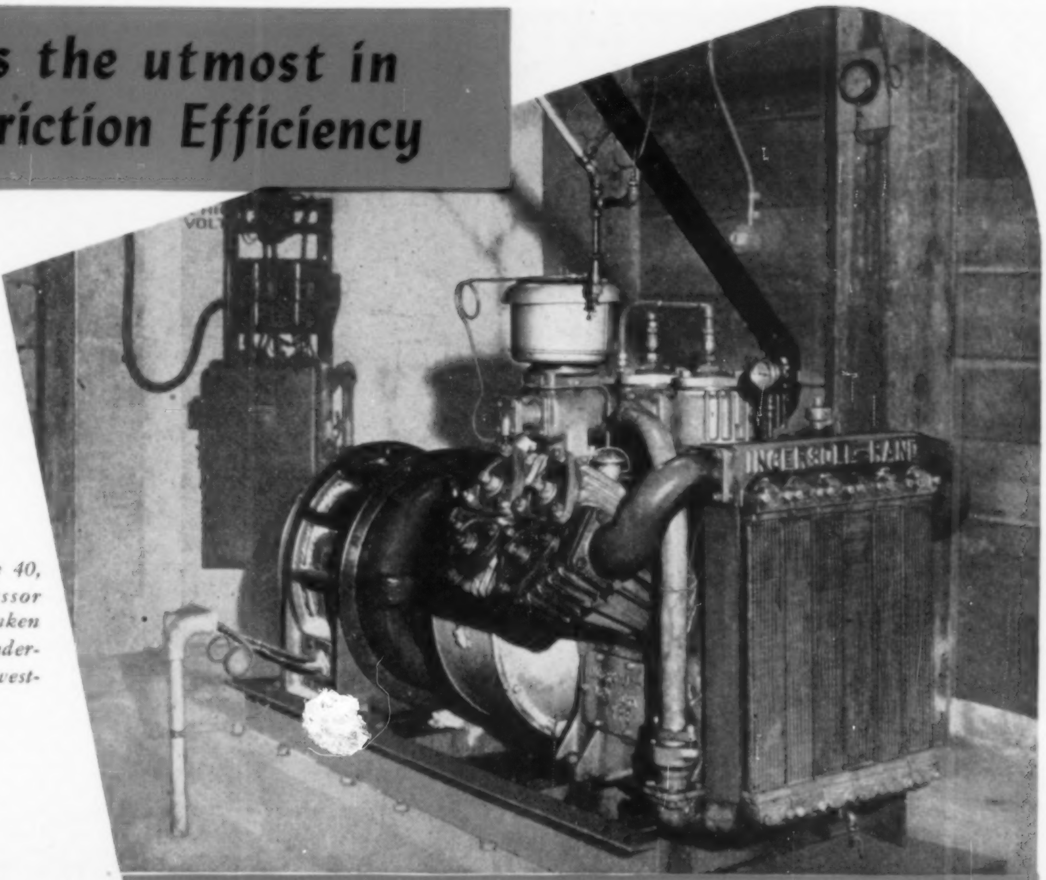
Johnston & Jennings "U.S." Jolt Roll-Over, Pattern Draw Molding Machine No. 815.

Left: Close-up view of NOPAK ½" 5-position Manifold Valve. This is essentially a 3-way valve for staggered actuation of 2 single-acting cylinders.

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

A 5089-½HA

Here's the utmost in Anti-Friction Efficiency



Ingersoll-Rand Type 40, 50 h.p. air compressor equipped with Timken Bearings installed underground at a large western metal mine.

Timken Bearing Equipped

When you decide to buy an anti-frictionized compressor, decide at the same time to obtain anti-friction advantages in full; specify "Timken Bearing Equipped" and be sure of getting them.

Timken Tapered Roller Bearings provide unexcelled smoothness of operation — but they do more than that; they protect compressor crank shafts against radial, thrust and combined loads; and hold them in constant alignment under all operating conditions. Thus Timken Bearings increase compressor endurance; extend compressor life; and reduce maintenance expense.

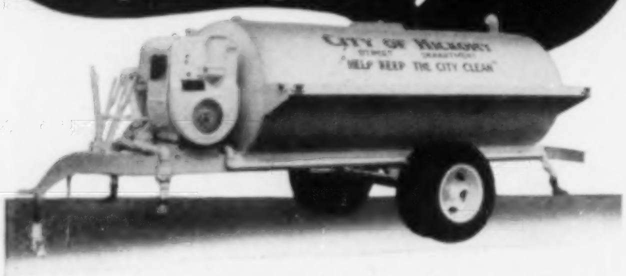
Many leading makes of compressors are equipped with Timken Roller Bearings; thus you have a wide range of choice in compressors of all types. The Timken Roller Bearing Company, Canton 6, Ohio.

Tapered Roller
TIMKEN BEARING
EQUIPPED

When buying bearings for original equipment or replacement, look for the trade-mark "TIMKEN" on every bearing.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

A CLEAN ENGINE
For a Clean Job!



The Model VE4 Wisconsin Air-Cooled Power Unit which supplies dependable power for the "City of Hickory" street flusher, made by Gunnison Manufacturing Co., of Baraboo, Wis., conforms in every detail to the clean-cut, streamlined beauty of the equipment of which it is an integral part. Delivering 22 hp. at 2600 R.P.M., this Wisconsin Engine provides steady-going, heavy-duty serviceability and ample power for the job . . . and it fits the equipment with "tailor-made" nicety.

If YOU have a problem in connection with your equipment, calling for self-contained engine power within a 2 to 30 hp. range, you may find a ready solution in the Wisconsin Air-Cooled Engine line. Detailed data on request.

Most H.P. per pound

WISCONSIN MOTOR Corporation

MILWAUKEE 14, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

FOR AIR COMPRESSORS

class 9213AH3

PRESSURE SWITCH

200 lbs. pressure limit
15 to 40 lbs. differential

• A two-pole device for intermediate-sized motors. Simply-designed, huskily-built mechanism delivers long life and trouble-free operation with a minimum of servicing.

Quickly wired. Range and differential easily adjusted in the field. Offered with or without pressure-release valve for easier motor starting.

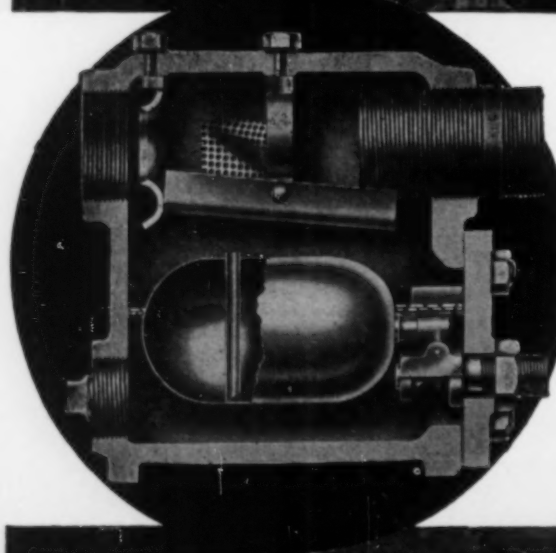
Write for Bulletin • photos, specifications of Square D pressure switches and related devices. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

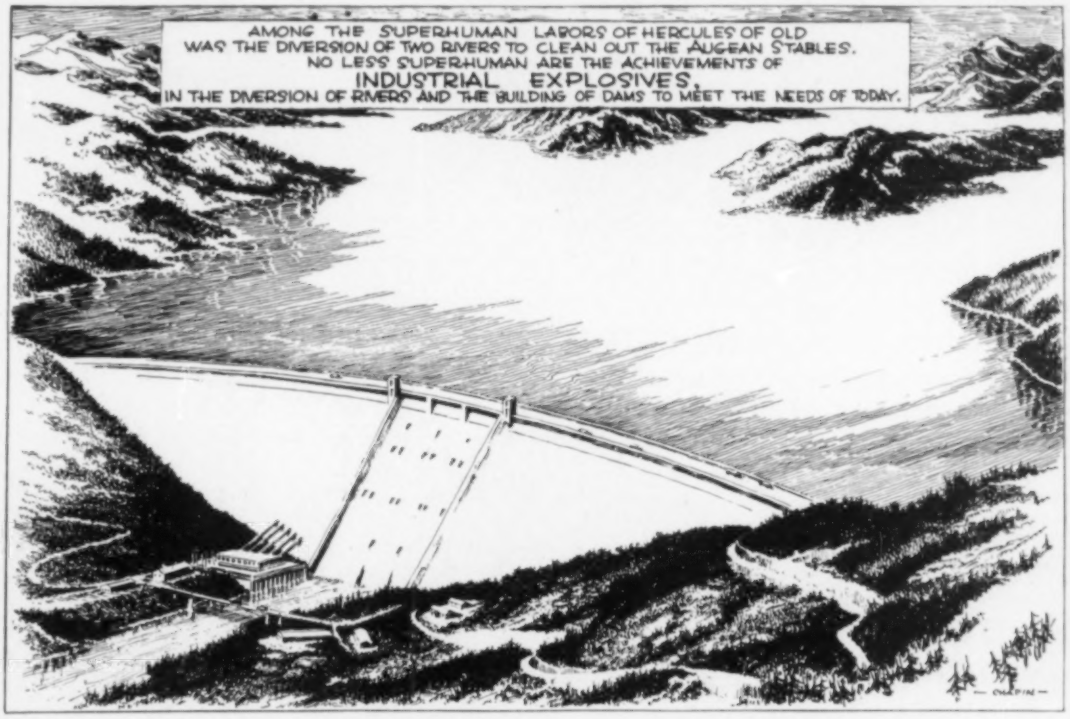
WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

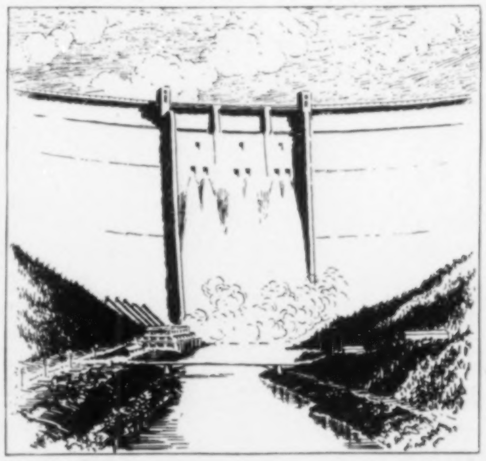
The Labors of a Modern Hercules – DAMS



AMONG THE SUPERHUMAN LABORS OF HERCULES OF OLD WAS THE DIVERSION OF TWO RIVERS TO CLEAN OUT THE AUGEAN STABLES. NO LESS SUPERHUMAN ARE THE ACHIEVEMENTS OF INDUSTRIAL EXPLOSIVES, IN THE DIVERSION OF RIVERS AND THE BUILDING OF DAMS TO MEET THE NEEDS OF TODAY.

EXPLOSIVES MAKE POSSIBLE THE DIVERSION AND CONTROL OF RIVERS IN CONSTRUCTING THE ENORMOUS FLOOD AND IRRIGATION CONTROL DAMS OF THE WEST. EXPLOSIVES GOUGE OUT TUNNELS, CARVE OUT ROADS, RELOCATE RAILROADS, BLAST THE ROCK AND STEEL AND OTHER NEEDED METALS WHICH GO INTO THESE HUGE WEDGES OF CONCRETE HIGH UP IN THE MOUNTAINS.

HUNDREDS OF WAGON-MOUNTED DRILL RIGS BORE THOUSANDS OF HOLES FOR EXPLOSIVES TO BLAST MILLIONS OF TONS OF ROCK.



EXPLOSIVES BLAST ROADS AND TUNNELS THROUGH THE MOUNTAINS WHICH SKIRT THE MAN-MADE LAKES BACKED UP AGAINST GIGANTIC DAMS.

THESE COLOSSAL MOUNTAINS OF POURED ROCK ARE EVEN HIGHER THAN NIAGARA. INVOLVED IN THEIR CONSTRUCTION, WITH THE AID OF EXPLOSIVES, ARE THE EXCAVATION OF MILLIONS OF TONS OF EARTH AND ROCK AND THE PLACEMENT OF MILLIONS OF CUBIC YARDS OF CONCRETE, ORIGINALLY BLASTED FROM QUARRIES AS ROCK, AND MADE INTO CEMENT.

HERCULES

HERCULES POWDER COMPANY
INCORPORATED
932 King St., Wilmington, 99, Del.

XR7-Z

FOR TODAY'S TOUGHER JOBS, HERE'S A NEW TOUGHER MOTOR

WHERE IT'S WET Wet weather doesn't bother the new totally-enclosed Tri-Clad motor. Neither do frequent "washdowns" in food plants.

WHERE IT'S CORROSIVE Acids, alkalis, and fumes are kept out of these new Tri-Clads. Cast-iron enclosures are corrosion-resistant, extra strong.

WHERE IT'S DIRTY Dirt and dust can't get into these Tri-Clads to shorten their life. Smooth surfaces are convenient to clean.

WHERE IRON DUST FLIES Harmful iron dust and metal filings can't get past the inner wall. Bearings are protected from dust.

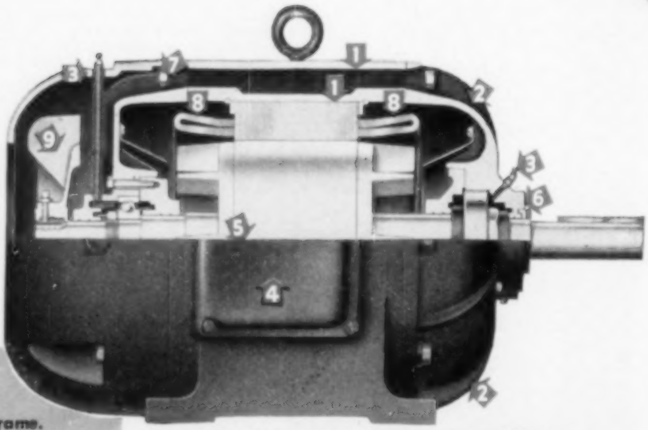
WHERE QUARTERS ARE CLOSE When space is limited for a totally enclosed motor, you'll like these trim, compact new Tri-Clads.

WHERE EXPLOSION HAZARDS EXIST The new Tri-Clad motors are available in explosion-proof constructions where needed.

THE G-E *TRI CLAD* TOTALLY ENCLOSED MOTOR

(1 TO 1000 HP)

In 1940 you welcomed the Tri-Clad open motor with it's *extra protection features*. More Tri-Clads have since gone into service than any other integral-horsepower motor. Now G.E. is ready with a new line of tough, totally enclosed Tri-Clad motors for use in adverse atmospheres. *We believe they are industry's most dependable motors.* Their longer life and lower maintenance will make them a sound investment on almost every job. Apparatus Dept., General Electric Co., Schenectady 5, N. Y.



10-POINT PROTECTION

1. A cast-iron, double-wall frame completely encloses and protects the windings and punchings.
2. Corrosion-resistant cast-iron end shields are machined to provide a tight seal, and protect the motor from dust, dirt, and moisture. Primer and finish coat of Glyptal* varnish affords high rust-resistance.
3. A pressure-relief greasing system, which can be packed with long-life lubricant, protects the bearings.
4. The cast-iron conduit box is diagonally split for easy wiring. Boxes are independently explosion-proof on Class I motors.
5. Nonshrinking compound around motor leads protects motor interiors from dust and moisture at the point where leads pass through the frame.
6. Rotating labyrinth seal further protects motor interior from damage by foreign matter.
7. Large air passages provide adequate protection from overheating. They're easy to keep clean and open, too.
8. Modern, "ageless" insulation treatment includes windings of *Formex magnet wire.
9. The powerful external fan is removable to simplify maintenance; nonsparking type in explosion-proof motors.
10. Individual dynamic balance of rotors and external fans protects against vibration hazards, even under severe operating conditions.

Trade-mark Reg. U. S. Pat. Off.

FOR THE COMPLETE STORY

Apparatus Department, Section MM750-278C
General Electric Company
Schenectady 5, N. Y.

☐ Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motors.

☐ Please send me GEA-4131, "Motors and Control for Hazardous Locations."

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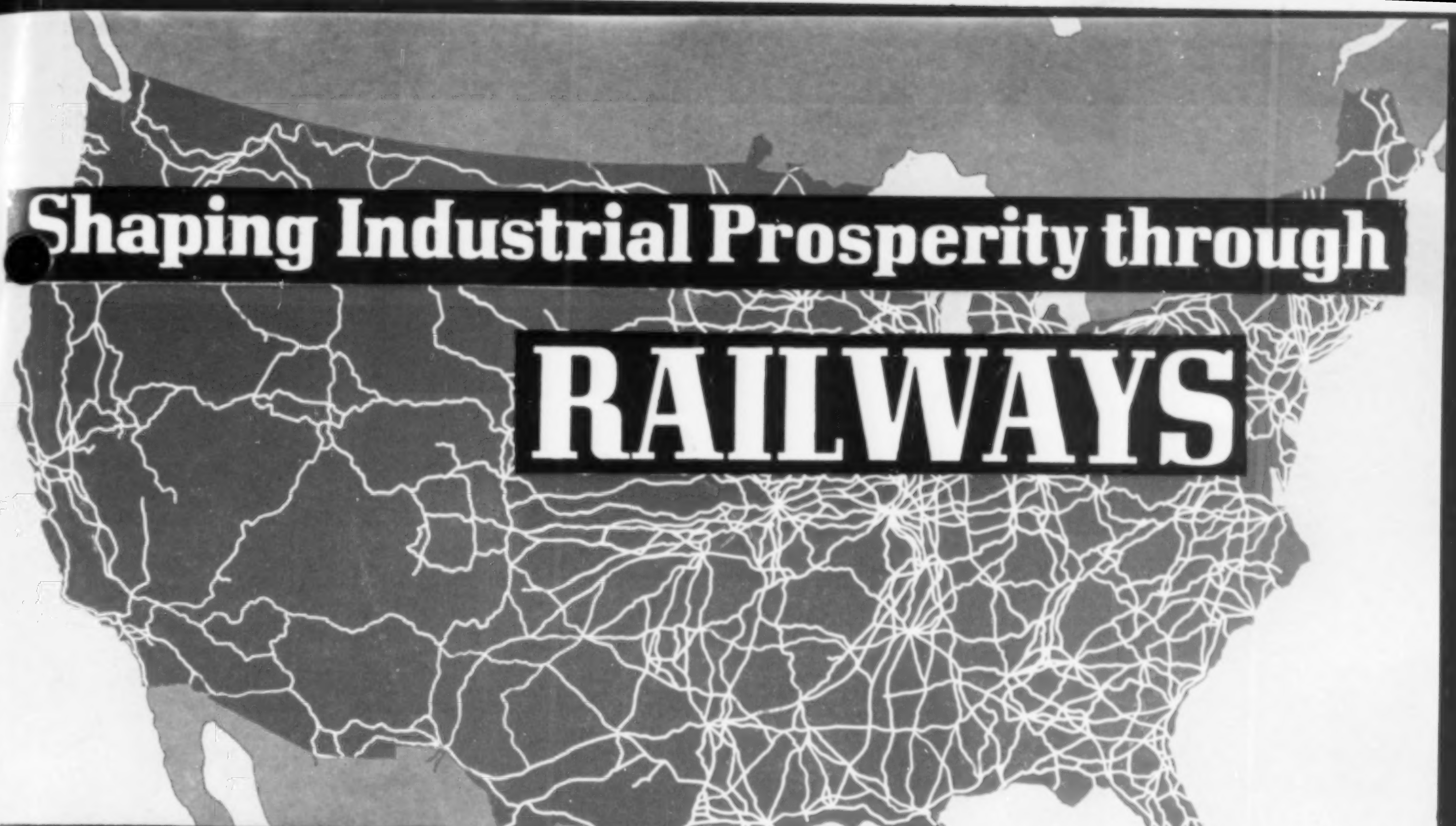
GENERAL ELECTRIC

Shaping Industrial Prosperity through

RAILWAYS



> "Railroad prosperity depends on national prosperity and a high rate of production. Beset with complicated problems involved in reconversion and with prospects of keen competition, the railroads are determined to maintain their position as the one indispensable mass transportation agency."
>
> From an article in Railway Age by Dr. Julius H. Parmelee
> Director, Bureau of Railway Economics

MAINTENANCE OF ROLLING STOCK

CONSTRUCTION OF RIGHT OF WAY

TRACK MAINTENANCE

14-914

"I've Been Working on the Railroad" is more than a quartet favorite—it's a reminder of the courage and ability of those who pioneered and developed, and of those who operate the world's greatest transportation system.... Greatest, because with only six per cent of the world's population and six per cent of its area the United States has nearly 30 per cent of the world's railway mileage.... Greatest because these tracks carry more than 50,000 trains daily, delivering men, food, mail and materials when and where needed—the world's greatest volume of transportation.

All of which means that the railroads are among the biggest purchasers of all types of equipment.

One person in every one hundred of our population is "Working on the Railroad." Nearly 900,000 are stockholders. These people and their families are a tremendous market for all kinds of goods and services.

Yes, the growth, maintenance and prosperity of our railroads is of extreme importance to our greater National Prosperity.

INGERSOLL-RAND equipment will continue to serve the railroads as it has for three-quarters of a century. I-R air-operated tie tampers revolutionized track maintenance methods. Compressors, air tools, pumps and other machines serve the railroads and those manufacturing railroad equipment.

Ways to do it

TIE TAMPERS • ROCK DRILLS •
CENTRIFUGAL PUMPS •
AIR TOOLS AND HOISTS •
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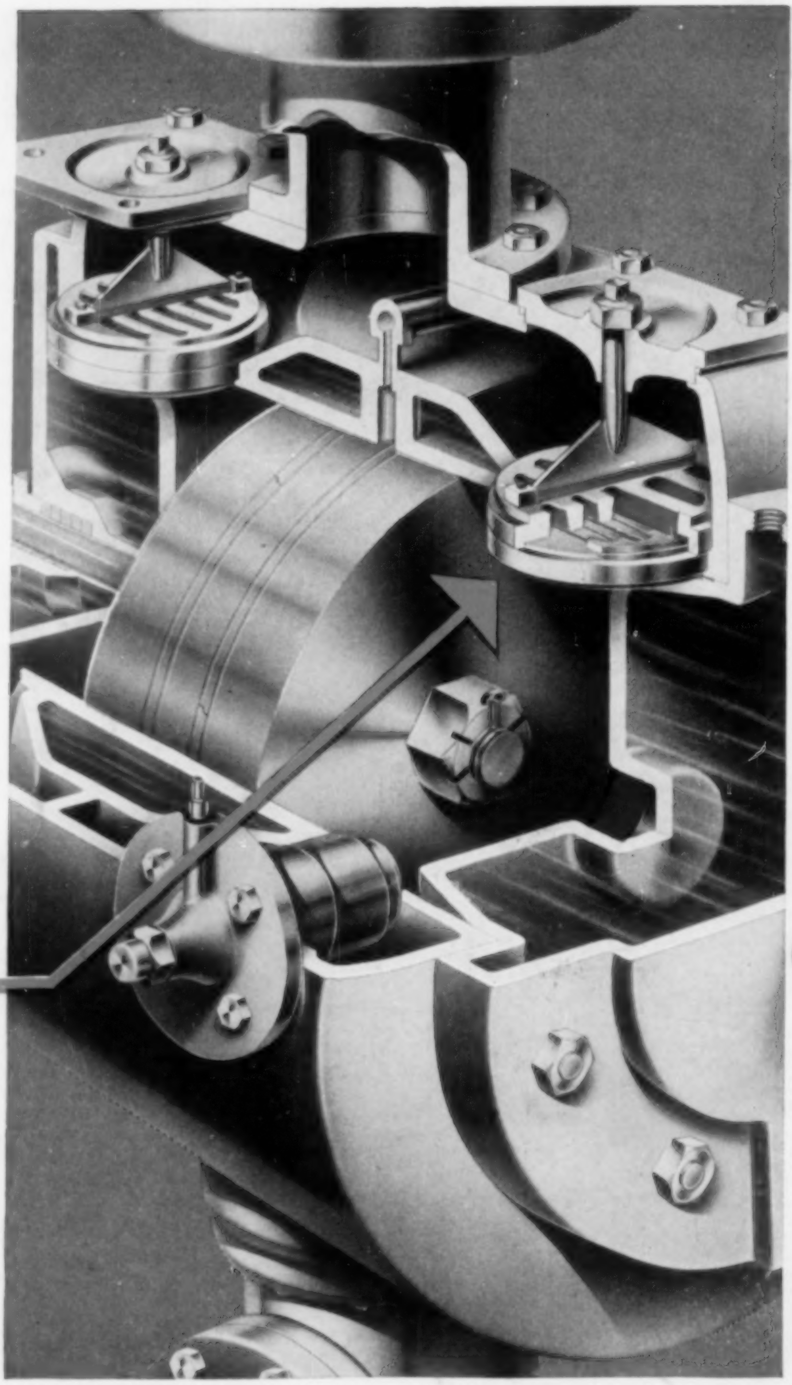
11 BROADWAY, NEW YORK 4, N. Y.

Inside Knowledge on Lubrication Problems

—VALVE DEPOSITS—

This is One of a Series of Messages on Common Problems in Your Plant

No Place for Deposits



Here's a spot in your plant where freedom from deposits pays. It's the discharge valve of your air compressor.

Hot compressed air, rushing through this valve, attacks the lubricating oil. Unless the oil resists oxidation under the extreme heat, you get hard carbon deposits that clog the valve, cause air leakage and loss of efficiency.

The proved solution to this problem is Gargoyle D. T. E. Oil, now in use in thousands of air compressors all over the world. This famous oil possesses exceptional chemical stability to reduce deposits to a minimum. It forms strong films to protect vital parts against wear.

With this oil in your compressor, your valves stay clean longer. You can maintain air compression at capacity levels with minimum time lost for maintenance.

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and Affiliates: Magnolia Petroleum Company
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